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FIRE CONTROL NOTES

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FIRE CONTROL NOTES

A quarterly periodical devoted to forest fire control

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COVER.—This newly developed high-volume spray effectively applies fire retardant chemicals along a strip up to 60 feet wide. See related article on page 4.

(NOTE—Use of trade names is for information purposes and does not imply endorsement by the U.S. Department of Agriculture.)

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THINNING AS AN AID TO FIRE CONTROL

Robert H. Cron, *Assistant Regional Forester*
Division of Timber Management
Northern Region

Foresters and fire control people have often debated whether the slash created by thinning dense, young stands of conifers posed a greater threat to controlling fires than the original stand. Many have felt that the volume of dry fuel created by thinning would accentuate the control problem.

During August of the very severe season of 1967 in northern Idaho, northeastern Washington, and all of Montana, several thinned stands were burned by wildfire. On at least three fires, thinned stands aided in controlling fast-spreading fires under Extreme burning conditions.

A large fire in Glacier Park, across the North Fork of the Flathead River, crowned rapidly through dense pole stands of lodgepole, larch, and Douglas fir. At a bend in the river, it spotted across onto the Flathead National Forest into an unthinned lodgepole-larch stand (fig. 1). It crossed this stand as a crown fire, but when it hit an adjacent thinned stand it dropped to the ground. Although the surface fire was hot, the spread was much slower and the fire was checked by dozers and backfire at 50 acres (fig. 2). The aspect in both the thinned and unthinned stands was flat to rolling.

Again, on the Miller Creek fire of the Flathead, thinned stands aided control actions. The north flank of this 800-acre fire crossed Keith Mountain Ridge, crowning rapidly through a sapling and pole stand until it hit a thinned area. At this point, the fire dropped to the ground and spread much slower, enabling dozers and crews to complete lines on that sector during the night. Again the aspect or topography was no different between the thinned and unthinned stands. Green brush (mostly alder) was growing heavily as an understory beneath the thinned larch.

The Cotter Bar fire burned 7,100 acres on the Nezperce Forest. On the second day, it reached a series of clearcut blocks and a thinned area of ponderosa pine. Although the clearcuts and planted areas checked the fire and ultimately contributed to its control, it did burn between and over some of the plantations. Crews were able to backfire from the thinned area. The backfire burned hot but did not crown rapidly in adjacent unthinned areas, and it became one anchor point of the final control line.

In all three of the cases cited, the thinning slash was left on the ground. All areas had been thinned since 1962.

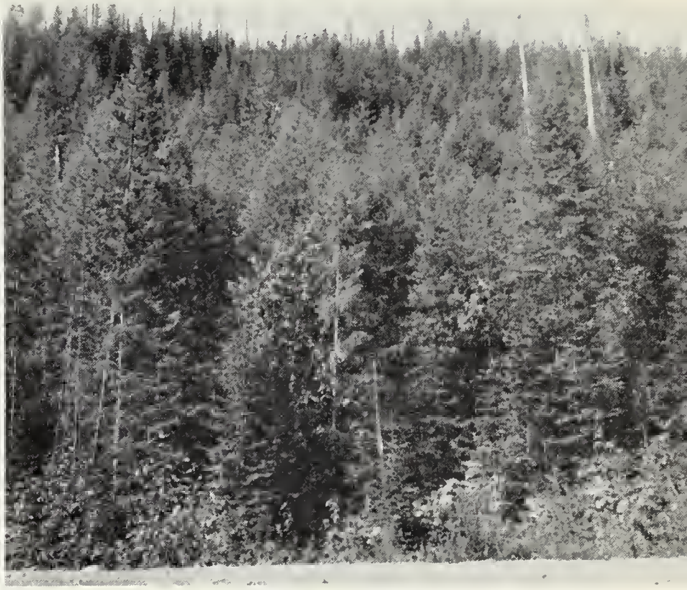
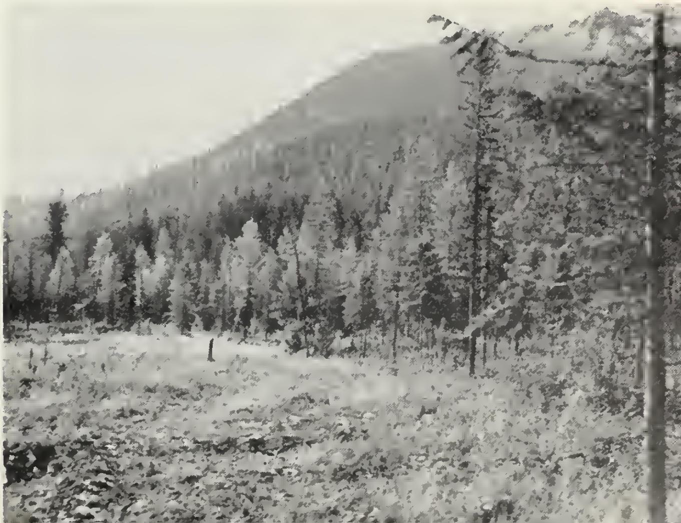


Figure 1.—A view of typical conditions in the unthinned stand through which the fire burned.

Editor's Note:—Mr. Cron has written on a controversial subject which we believe is of interest to many *Fire Control Notes* readers. We would like to receive other articles on experiences with thinning slash, particularly articles detailing the effects of its presence on fire behavior and suppression.

Figure 2.—View showing thinned stand where fire was stopped. Cleaned area on left was dozer-piled and burned after the wildfire.



HIGH-VOLUME RETARDANT SPRAYER

ARTHUR H. JUKKALA, *Forester*
Missoula Equipment Development Center

In the past decade, prescribed burning by many land management organizations has increased in both size and cost. Complexity has also increased because of accumulations of untreated logging slash and trends toward summer burning.

As prescribed burning has increased, so has the need for tools to accomplish such burning safely and efficiently. The Missoula Equipment Development Center is currently developing several tools for prescribed burning. One is a high-volume sprayer for ground application of retardants.

Several National Forests, other Federal agencies, and State agencies are now pretreating prescribed burn perimeters with fire-retardant chemicals to minimize problems related to the spread of spot fires. Reports indicate this practice is effective and offers a good chance of saving money. However, the availability of equipment for efficient application of the fire-retardant chemicals has been a problem.

The Missoula Equipment Development Center contracted for the construction of a sprayer that hopefully would improve efficiency in mixing and applying chemicals to perimeters of prescribed burns, high-hazard roadsides, and wildfire control lines.

The sprayer was custom-assembled from stock components to meet performance requirements established by the Center. It was received in the fall of 1967, and used for familiarization trials and on two prescribed burns.

The overall design, construction, and performance of the sprayer exceeded expectations in initial tests. The key design and performance features include:

Tank.—1,000-gallon capacity; double-baked, epoxy-coated to resist corrosion; three-paddle agitator mixer; and three-point torsional suspension for operation on uneven terrain.

Pump.—Two-stage certrifugal; 100 g.p.m. at 200 p.s.i.; double-baked, epoxy-coated; 1½-inch handline outlet.

Blower Assembly.—Manually operated turntable (360-degree horizontal plane); hydraulically operated blower outlet with 90-degree vertical control (45 degrees above the below horizontal); electric solenoid valves for nozzles and bypass line; 50,000 cu. ft./min. air displacement, and four independently adjustable nozzles to insure thorough, even retardant coverage and a wide swath (fig. 1).

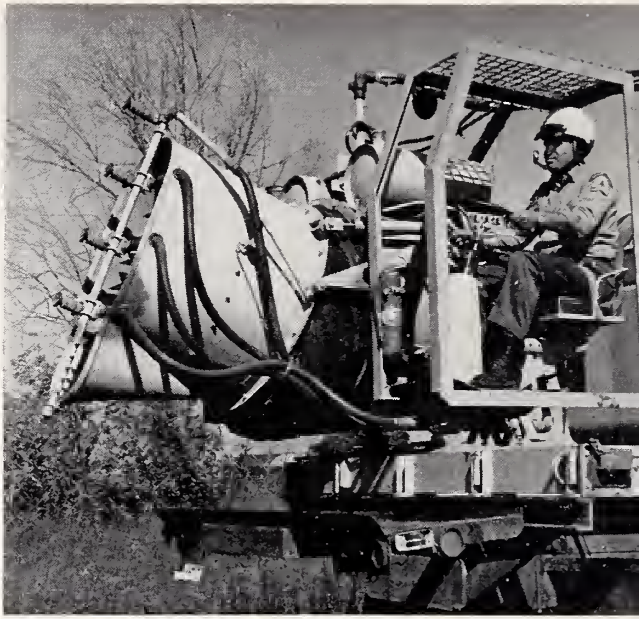


Figure 1.—The sprayer blower assembly. Direction of spray, width of swath, and application rate is readily controlled by operator.

Filling and Mixing.—Auxiliary pump is required for filling; total fill and mix time is approximately 15-20 minutes.

Spraying.—Uniform coverage for swaths up to 60 ft. wide. For a 50-ft. swath at an application rate of 2 gal per 100 sq. ft., the vehicle must travel at approximately 1 m.p.h. One tank (1,000 gal.) will cover 1,000 linear ft.

A few minor additions and modifications were made in 1968. These were:

1. Protective canopy for blower operator.
2. Electrically controlled power traverse for moving blower across truckbed.
3. Larger pump-tank bypass for better pump cooling and mixing of caked retardants.
4. Independent opening and closing for top and bottom pairs of nozzles.
5. Mounting on 6 by 6 military surplus vehicle for greater mobility.

Phos-chek 259 slurry of 360-centipoise viscosity has been sprayed easily. Although Pyro, DAP, or Phos-chek 465 have not been tested, no problems are anticipated. In 1968, the improved model was used on many prescribed burns in the Northern Region. No problems with corrosion, wearing parts,

(Continued on page 12)

TRACER SHOTSHELL FIRES: A NEW HAZARD

MARVIN DODGE, *State Forest Ranger, California Division of Forestry*[1]

The recent development of tracer shotshells has added a new twist to the fire prevention problem. These shotshells are not a fire hazard *when they are used as intended*, primarily for training in trap and skeet shooting. On the cover of each packet of shells, there is a warning stating that they should be used "at gun clubs only . . . Use in the field for hunting is not recommended."

But some hunters may be tempted to fire tracer shotshells. In experiments we started fires by firing shells directly into matted grass and punky logs. The shell leaves its own evidence: the spherical tracer vehicle and a special doughnut-shaped wad.

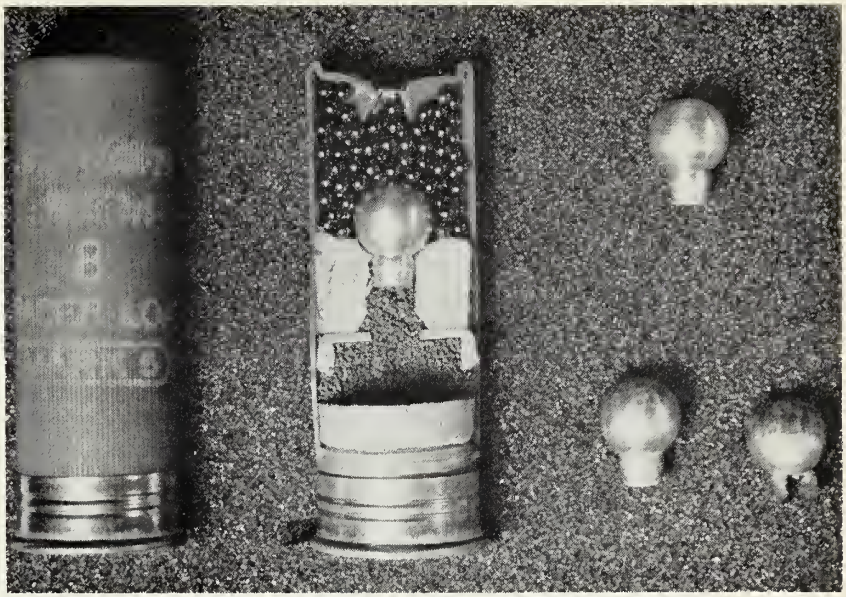


Figure 1.—A tracer shotshell is shown. At center is sectioned shell of tracer vehicle and "doughnut" wadding. At lower right are two fired tracer vehicles recovered from target area. The tail on one of the vehicles was broken when it struck a knot in a punky log and started a fire.

The shells, which are manufactured only in 12-gage, No. 8 shot, include the tracer charge carried in an aluminum alloy vehicle—a sphere with a short tail (fig. 1). The charge itself, in the tail of the sphere, is magnesium powder, a peroxide, and a plastic binder.

The overpowder wad in the tracer load differs from a normal shotshell wad. Its center is cut out so the tracer element can be ignited by the burning propellant powder. Shaped like a thick doughnut, the wad is quite distinctive.

Many gun clubs forbid tracer loads to be used on their ranges. In our experiments at a local gun club, we had to obtain special permission from the officers to use tracers. We fired several shots horizontally to determine the burning distance; in none of the tests could we detect tracers beyond 60 yards. Apparently any shots fired in the air will safely burn out and cool before the tracer vehicle falls back to the ground. The streak of fire from the tracer is evident at night, but in the day the shooter seldom sees the tracer.

When we fired 12 shots into dry fuels from 5 to 15 yards, we started two fires. One fire flared in heavily matted grass and light brush; the other started in a partly rotted log. In these tests air temperature was 95°. Relative humidity varied from 26 to 28 percent. The ignition index at the two nearest fire-danger-rating stations was 85 and 66.

To determine how far the flame projected from the vehicle, we went to a laboratory and ignited the tracer compound with a miniature heating coil (fig. 2). Flame lengths were scaled from photographs of the burning tracer.

Burning times of the tracer charges ranged from one-fourth to one-third of a second. During this split second, the charges hurled forth an intense flame and cascaded droplets of molten slag from 8 to nearly 40 inches from the vehicle (fig. 3).

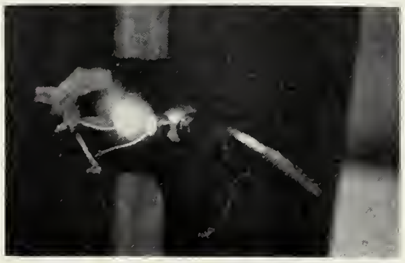


Figure 2.—In the laboratory a miniature heating coil was used to ignite a tracer vehicle of the shotshell.

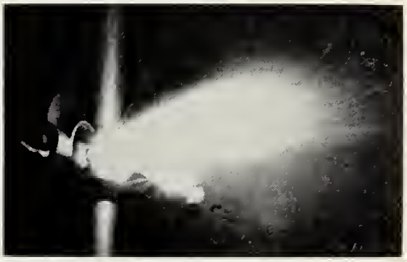


Figure 3.—After ignition, flame projected from tracer vehicle clamped in stand. Streaks are from molten slag.

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[1] The author is currently assigned to the Pacific Southwest Forest and Range Experiment Station, Berkeley, Calif. He is stationed at Riverside, Calif.

EPOXY ADHESIVES FOR TOOL REHANDLING

Eugene T. Gould, *Fire Control Officer*
Shasta-Trinity National Forest

For years firemen have faced the problem of tool handles becoming loose, whether a tool was in use or in storage. The heads of firetools such as Pulaskis, brush hooks, and axes frequently become loose at the most embarrassing or critical times—usually when being checked by an inspector or on the fireline!

Since 1961 personnel of the Weaverville District have been using epoxy adhesives when rehandling tools. Tools may be stored for long periods without the handles becoming loose. Hard use on fireline construction has resulted in very few handle failures and no loose handles resulting from storage.

The following steps are used in rehandling tools:

1. All oil, paint, and dirt is removed from the eye of the tool. A file or wire brush aids in cleaning. The eye must be clean to secure a good bond between the handle and metal.
2. The handle is fitted to the eye in the usual manner, but the handle must fit without forcing. (The epoxy will fill minor imperfections between the handle and the metal.)[1]
3. Coat the section of the handle which fits the eye with epoxy, and put the handle into the eye (fig. 1).
4. Coat the wooden wedge with epoxy and drive it into place. Sufficient epoxy should be put on the wedge to completely fill the slot cut for the wedge (fig. 2).
5. Remove excess epoxy and cut off wedge flush with toolhead.
6. Seal handle at head with coating of epoxy. Usually enough excess epoxy is left to do this job, providing a smooth, weathertight finish.
7. Let epoxy set for 24 hours before using tool.

New tools may also be epoxied by removing the wooden wedge from the handle, knocking the handle out, and then proceeding as described.

Epoxy filler has been very satisfactory to use, and it is much less expensive than the clear epoxy adhesives. Eight ounces of filler costs approximately $1.50 and will permit 20 to 50 tools to be rehandled.

As with all epoxy adhesives, the material must be handled carefully, and the safety precautions on each container must be followed.

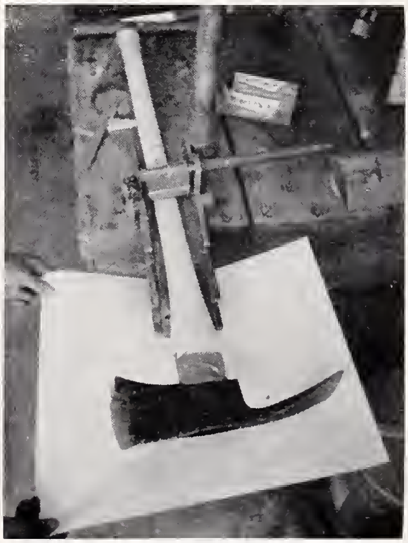

Figure 1.—Toolhead started onto epoxy-coated handle.

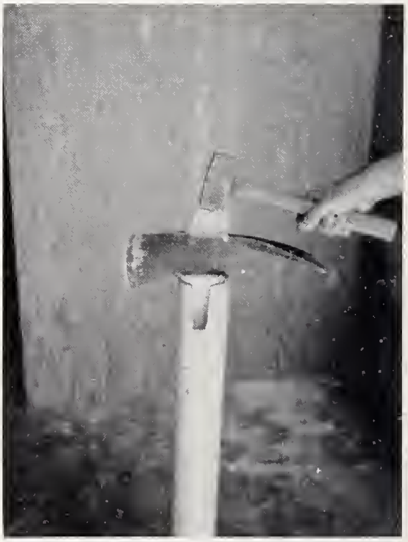

Figure 2.—The wedge should be coated with epoxy prior to being driven into the handle.

Editor's note: Studies by the Missoula Equipment Development Center to find improved methods for handling tools substantiate Mr. Gould's findings and conclusions.

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[1] See Forest Service Handbook 5109.12—Firemen's Handbook, Chapter 60, for rehandling instructions.

ADEQUATE PRESUPPRESSION MANNING DEPENDS ON ACCURATE FIRE-WEATHER OBSERVATIONS

ARTHUR R. PIRSKO[1] and PAUL G. SCOWCROFT[2]
Pacific Southwest Forest and Range Experiment Station

Presuppression manning and fire-weather observations, while distinct entities, are directly related. These two operations are both related to the fire-danger rating index. Fire-weather observations are used to calculate the danger index; the index, in turn, is used to determine presuppression manning requirements. Therefore, inaccurate fire-weather readings can indirectly result in erroneous manpower requirements.

The primary reason for inaccurate observations is improper maintenance of instruments. Lowering maintenance standards nearly always reduces the danger indexes, and consequently, the manning requirement. The relation of these three variables can easily be comprehended if we examine the more common equipment problems associated with the measurement of three key variables—fuel moisture, relative humidity, and windspeed.

Fuel-Moisture Readings

Fuel-moisture stick readings can be altered from the norm by several factors; the most subtle is shading of surrounding vegetation. Partially shaded sticks have a higher moisture content than those fully exposed; consequently, the danger index will be lower. Other factors contributing to erratic readings include mud, dust, bird excreta, body oil from hands, and weathering. They can change the weight, hygroscopic characteristics, or both of the moisture stick. For instance, weathered sticks will always have low readings, causing the danger index to be above the actual.

The Region 6 Western Type fuel-moisture scale may also provide erroneous readings as its bearing surfaces become worn. The pressure and movement of the steel pin of the scale beam enlarges the hole of the U-shaped support bracket (fig. 1). When the scale is used, the pin will climb the side of the hole, changing the fulcrum point and resulting in an error in measurement. However, the U-shaped support bracket can be replaced with one that has stainless steel inserts for the bearing surface. An accelerated-use test showed no appreciable wear after 2,200 hours.

Relative Humidity Readings

The fan psycrometer—used to measure relative humidity—is another possible source of error. If the wick on the wet-bulb is dirty, short, or crusted with residue, the indicated wet-bulb temperature will be too high. This, in turn, will give an erroneous, high relative humidity reading. The same error occurs if the wet-bulb has not been cooled enough by fanning.

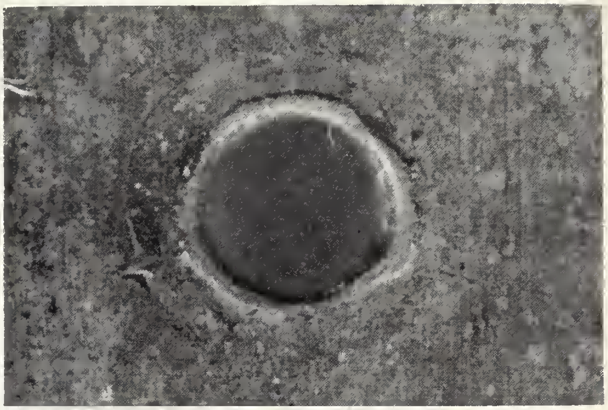

Figure 1.—The hole in the U-shaped support bracket of a fuel-moisture scale shows considerable wear after 2,200 hours of use.

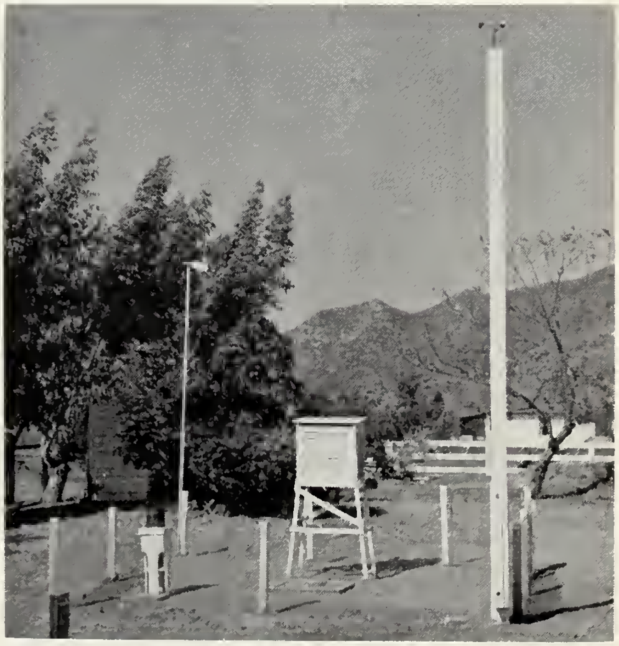

Figure 2.—The anemometer is sheltered from the true windspeed by the trees at the left. Raising the anemometer or trimming the trees would correct the situation.

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[1] Deceased 1966.

[2] The author(s) were/is stationed at the Forest Fire Laboratory, Riverside, Calif.

Windspeed Readings

Windspeed is the most critical factor that affects spread and danger indexes. Minor fluctuations will often cause large changes in index values. The windspeed measurement must be precise if an accurate danger rating is to be obtained.

Proper exposure of the anemometer is important if the true windspeed 20 feet above the tallest vegetation is to be measured. Growing vegetation can eventually shelter an anemometer from the true windspeed and thus result in low readings (fig. 2). Consequently, danger indexes will be correspondingly low.

Anemometers can also be slow because of improper servicing. Improperly lubricated bearing surfaces can become partially dried out, impeding the rotation of the cups, and an excessive lubricant will create the same problem. Other causes of low anemometer readings are faulty contacts and wiring, bent or damaged cups, and bent shafts. Each of these deficiencies will result in an incorrect, low reading of the danger index.

The effect of erroneous readings of relative humidity and windspeed on the fire-danger rating, manning, and success of initial attack in the California Region is illustrated in table 1. Comparative measurements at a station under proper and improper maintenance procedures are shown. The crusted wet-bulb gave a temperature 2 degrees too high, in turn, the reading raised the humidity 4 percent to 22. Similarly, the anemometer, which was dirty and sluggish, registered windspeed at 11 m.p.h. instead of a true speed of 15 m.p.h. The two errors compounded the burning index error. Instead of having a true burning index of 38, the improperly maintained station had one of only 25.

This difference of 13 index points can significantly alter the strength of initial-attack forces and their subsequent success or failure. If a fire was discovered on 0.2 acre in fuel type 6 (mixed Douglas-fir-white-fir with brush and reproduction), the number of men needed to control the head of the fire at an overall size of 10 acres could be determined from the chart (fig. 3) developed by Pirsko.[3]

Assuming an elapsed time of 34 minutes from discovery to attack, the number of men needed would be 10 and 19 for indexes of 25 and 38, respectively. Since 25 is lower than the true burning index, 10 men would not be enough to meet initial-attack goals—298 feet of line would be open at the head. However, 19 men would probably catch the fire by the time it reached 10 acres.

The need to maintain your weather stations and instruments is crucial. Proper maintenance habits can mean the difference between a small fire and a conflagration.

TABLE 1.—*Measured and computed values for properly and improperly maintained stations*

Item	Maintenance performance		
	Proper	Improper	Error
Dry bulb (°F)	85	85	0
Wet bulb (°F)	58	60	+2
Relative humidity (percent)	18	22	+4
Windspeed (m.p.h.)	15	11	−4
Burning index[1]	38	25	−13

[1] Based on the Wildland Fire Danger Rating System of Region 5.

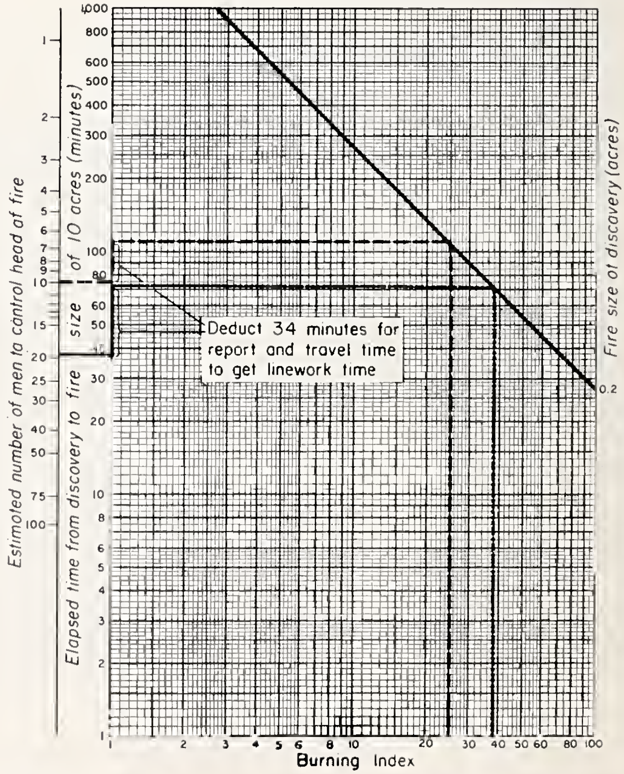

Figure 3.—The chart shows manpower required to suppress fire at 10 acres for mixed Douglas-fir-white-fir with brush and reproduction when the fireline construction rate is 1.1 chains per man-hour.

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[3] Pirsko, Arthur R. Why tie fire control planning to burning index? Fire Control Notes 22(1): 16-18. 1961.

SUPERIMPOSED LIGHTNING SCARS AND TREE-BOLE IGNITION BY LIGHTNING

ALAN R. TAYLOR, *Research Forester*
Intermountain Forest and Range Experiment Station[1]

This note presents observations on a little-known method of tree-bole ignition by lightning—a fire-setting discharge partially superimposes its furrow upon an older lightning scar and ignites the older injury.

Throughout the world lightning strikes thousands of trees every day. A discharge usually does not cause fire but inflicts structural damage on the struck tree. Damage ranges from a lack of obvious injury to virtual destruction of the tree.[2] In conifers, the most common damage is a shallow furrow from 2 to 10 inches wide that spirals along the trunk, exposing only the outer layers of sapwood in its path.[3]

Superimposed Lightning Furrows

Occasionally lightning strikes the same tree more than once during the tree's lifetime. A later discharge sometimes follows essentially the same path taken by a previous discharge along the tree bole. Thus, one furrow is partially superimposed upon the other one. Evidence of this has been seen on 11 live conifer trees in western Montana. Three of the lightning strikes caused fire. In all three instances, ignition evidently occurred in superimposed-furrow regions on the boles. This article briefly describes these three events; emphasis is placed upon the most recent ignition—the only one for which both the fire-setting discharge and its effects were documented.

Three Instances

My first experience with this phenomenon occurred on June 30, 1962. The day before lightning had struck and ignited a small (40-ft.-tall, 12-in.-d.b.h.) ponderosa pine (*Pinus ponderosa* Laws.) near Missoula, Mont. On the portion of the tree 10 to 30 feet above the ground was a shallow, spiral lightning scar several years old, partly closed and containing exuded resin. Superimposed on the lower end of this scar, which terminated about 12 feet above ground, was a new lightning furrow. Based on evidence at the scene and an interview with the smokechaser clearly indicated that the more recent discharge ignited the resin-covered fuel in the lower section of the older scar. A burning wood sliver, 3 feet long, was ejected from the old wound and stuck in the ground some 13 feet from the burning tree.

The second event occurred on July 15, 1963, when lightning struck and fired a large (96-ft. tall, 35-in. d.b.h.), live, open-grown ponderosa pine near Missoula. The tree had been struck from 37 feet to about 85 feet above the ground. The new furrow, which had many protruding slivers, was superimposed on the old scar for only 1 foot at the 37-38-foot level. Ignition occurred only in this 1-foot zone of superimposition. Exuded resin had collected at the base of the old scar and evidently was ignited by the most recent discharge.

The third ignited tree was a large (120-ft. tall, 40-in. d.b.h.) western larch (*Larix occidentalis* Nutt.) growing in a cutover stand of western larch, Douglas-fir (*Pseudotsuga menziesii* var. *glauca* (Beissn.) Franco), and ponderosa pine in the Lolo National Forest of western Montana. A growth-ring indicated the tree had been struck 6 years prior to the fire-setting discharge. The tree had lost its top many years earlier, and an upper branch had become the terminal leader.

The fire-setting discharge occurred at 1316:02 M.S.T. on Sept. 14, 1966. Its electrical properties were recorded electronically at a station 16 miles from the tree, and the visible flash and subsequent fire were documented by an airborne lightning observer.[4]

The (1) methods and equipment used in the lightning recording system and (2) characteristics of the discharge that caused this fire are described elsewhere by Fuquay et al.[5]

The burning tree is shown in figure 1, photographed by the observer about 1 minute after the discharge occurred. The new damage was superimposed for about 60 percent of the old scar's length. Portions of the new and old damage appear in figure 2. This shows a section from about 50 feet below the tree's tip to about 1 foot above the highest fire damage. Note the ridges of 6

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[1] The Station is located at Ogden, Utah. The author is stationed at the Northern Forest Fire Laboratory, Missoula, Mont.

[2] Taylor, Alan R. Lightning damage to forest trees in Montana. Weatherwise 17(2):12 61-65. 1964.

[3] Murray, J. S. Lightning damage to trees. Scottish Forest. 12(2):2, 70-71. 1958. See also Taylor, Alan R. Diameter of lightning as indicated by tree scars. J. Geophys. Res. 70(22) 5693-5695. 1965.

[4] J. E. Burns made substantial contributions in documenting lightning effects described in this article.

[5] Fuquay, D. M., Baughman, R. G., Taylor, A. R., and Hawe, R. G., Documentation of lightning discharges and resultant forest fires. U.S. Forest Serv. Res. Note INT-68, 7 pp. 1967.

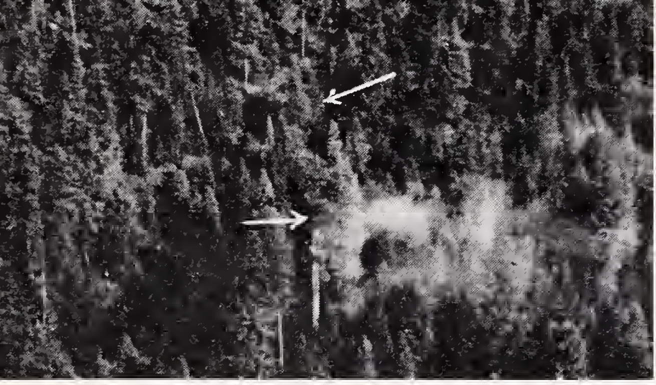


Figure 1.—Western larch struck and ignited by lightning; photographed about 1 minute after discharge. The upper arrow indicates the treetip; the lower arrow shows the highest level of smoke on tree bole. The section between arrows is a volunteer terminal leader.

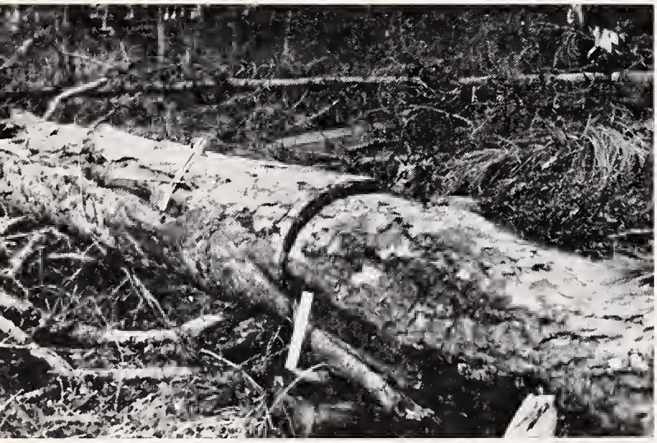


Figure 2.—New lightning damage partly superimposed on 6-year-old lightning scar. Lighter portion of furrow in upper part of scar is new damage. Callus tissue and thin sapwood strip were removed from this edge of furrow by the later, fire-setting discharge. The top of the tree is 50 feet to left. The ruler is 6 inches long.

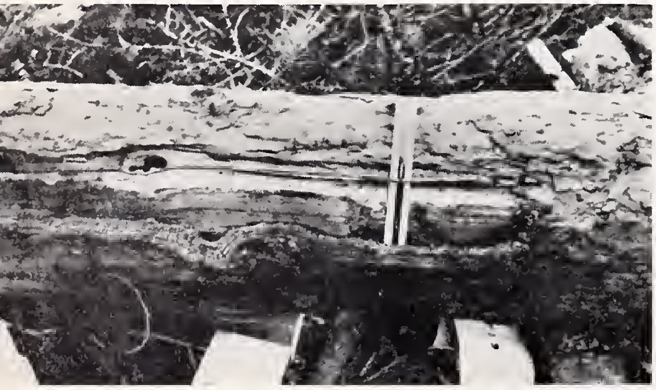


Figure 3.—Upper extremity of fire on tree bole, 6 inches above crosscut. Massive char and wood loss on underside of bole, right, corresponds with highest level of smoke (lower arrow, fig. 1).

years' callus tissue and the weathered, exposed sapwood on the edge of the old furrow (lower edge in photo). Compare this edge with the opposite edge, where the callus tissue was removed and a thin strip of sapwood was loosened by the fire-setting discharge. This appearance is typical of that of the other 10 trees on which superimposition of scars was observed. Also note that the old and new furrows appear to terminate at the right side of the photograph. Figure 3, however, shows that both furrows reappear about 1 foot lower on the bole. Here most of the evidence of the new furrow was destroyed by fire, but, as in figure 2, the callus tissue of the old wound was removed from the margin of the scar by the recent discharge.

The highest point of massive char (fig. 3, lower right) was about 55 feet below the tip of the tree, near the base of the volunteer main stem, and coincided with the highest point at which smoke obscures the bole in figure 1 (lower arrow). Thus, the older lightning scar at this point was a primary ignition site for the more recent discharge. The massive charring in this region precluded determination of the amount of resin exudation, if any, from the old wound. However, the old scar in figure 2 contained only small amounts of such deposits.

Figure 1 also suggests that ignition occurred at other points farther down the bole, either on the old lightning scar or in decayed heartwood of the lower trunk. Evidence from those areas was destroyed by fire and by severe breakage when the tree was felled to suppress the fire.

Discussion

The three instances described in this note show that tree-bole ignition by lightning sometimes occurs in an injury caused by a previous discharge. Therefore, the presence of exuded resin in an old lightning scar may increase the probability of tree-bole ignition by a later discharge. If it does, other types of injuries might similarly increase chances of bole ignition by lightning.

PORTABLE COLLAPSIBLE TANKS FOR DELIVERY OF WATER TO THE FIRELINE WITH HELICOPTERS AND CARGO SLINGS

JACK P. CURRAN, *District Fire Control Officer*
Los Padres National Forest

Since the advent of the helicopter in firefighting, numerous methods have been devised to deliver water on fires. Varying success has been attained. The biggest drawback of most of the methods has been the need for special attachments—restricting the use of the helicopter.

To devise a simpler method of delivering water to the fireline, we secured collapsible portable tanks with an 80- and 150-gallon capacity that can be sling-loaded and delivered to anyplace on a fireline where a helicopter can maneuver close enough to the ground to set off a sling load. The 80-gallon tank can be carried in a sling by the small helicopters commonly employed in fire suppression (fig. 1). When full, the larger tank can be carried by the larger helicopters now being used on many major fires.

When possible, the tanks are delivered on a ridge or high point of the fire so that delivery of the water from the tank to the fire can be by gravity flow through the hoseline (fig. 2). This situation is often encountered when work is done on slopovers on the back side of a ridge. The tanks have also been used for refilling 4 by 4 pickup pumpers that were holding a fire on a tractor line that was a great distance from a water source and was inaccessible to larger water-carrying vehicles.

When gravity pressure is not possible, the water can easily be pumped on the fire with the small, portable pumps now carried by most helitack crews. (fig. 3).

This small tank was designed so that it contained 70 gallons when the water level was at the bottom of the overflow line and vent on top of the tank, but it will contain 80 gallons when it is filled to the point where the water will flow out of the overflow, a 6-inch piece of garden hose. When a pump is to be sent in with the initial load of water, the tank loading should be restricted to 70 gallons to compensate for the weight of the pump.

With three tanks and cargo slings, one helicopter can normally keep a continuous supply of water on any trouble spot on a fire. This system can be particularly effective in backing up backfiring operations that are not accessible to motorized equipment.

This system has the following advantages:

1. A low-cost, lightweight, collapsible tank is utilized.

(Continued on page 16)

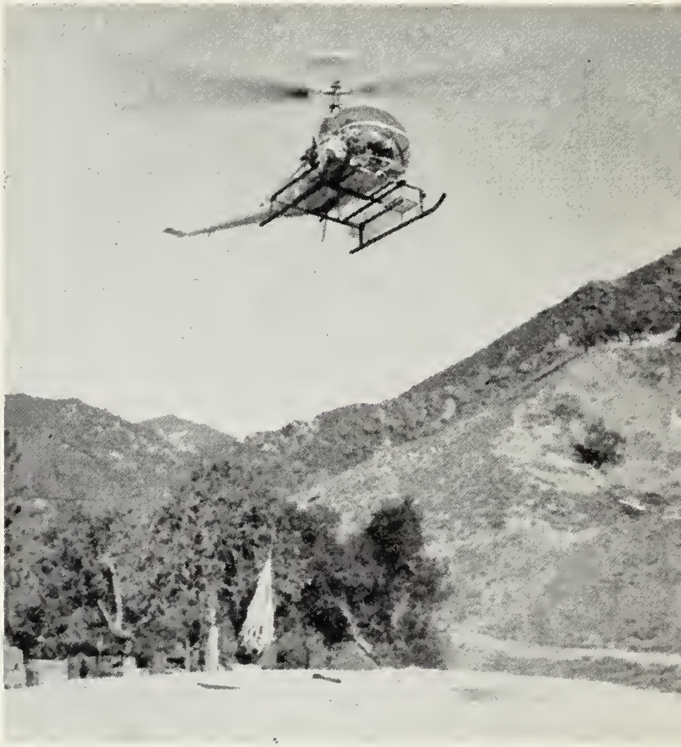


Figure 1.—A filled tank, hose, and pump can be quickly delivered to a remote section of the fireline by a small helicopter.

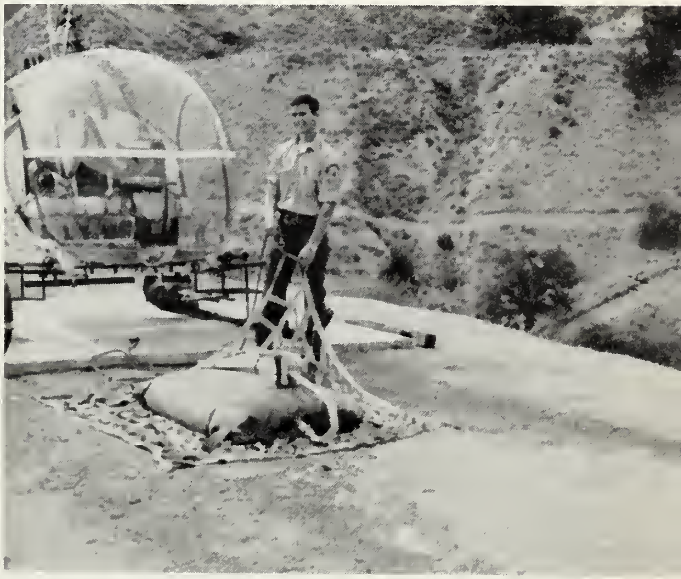


Figure 2.—An 80-gallon tank, hose, and nozzle ready for loading. Where gravity feed can be utilized, the water is available for instant use upon delivery.

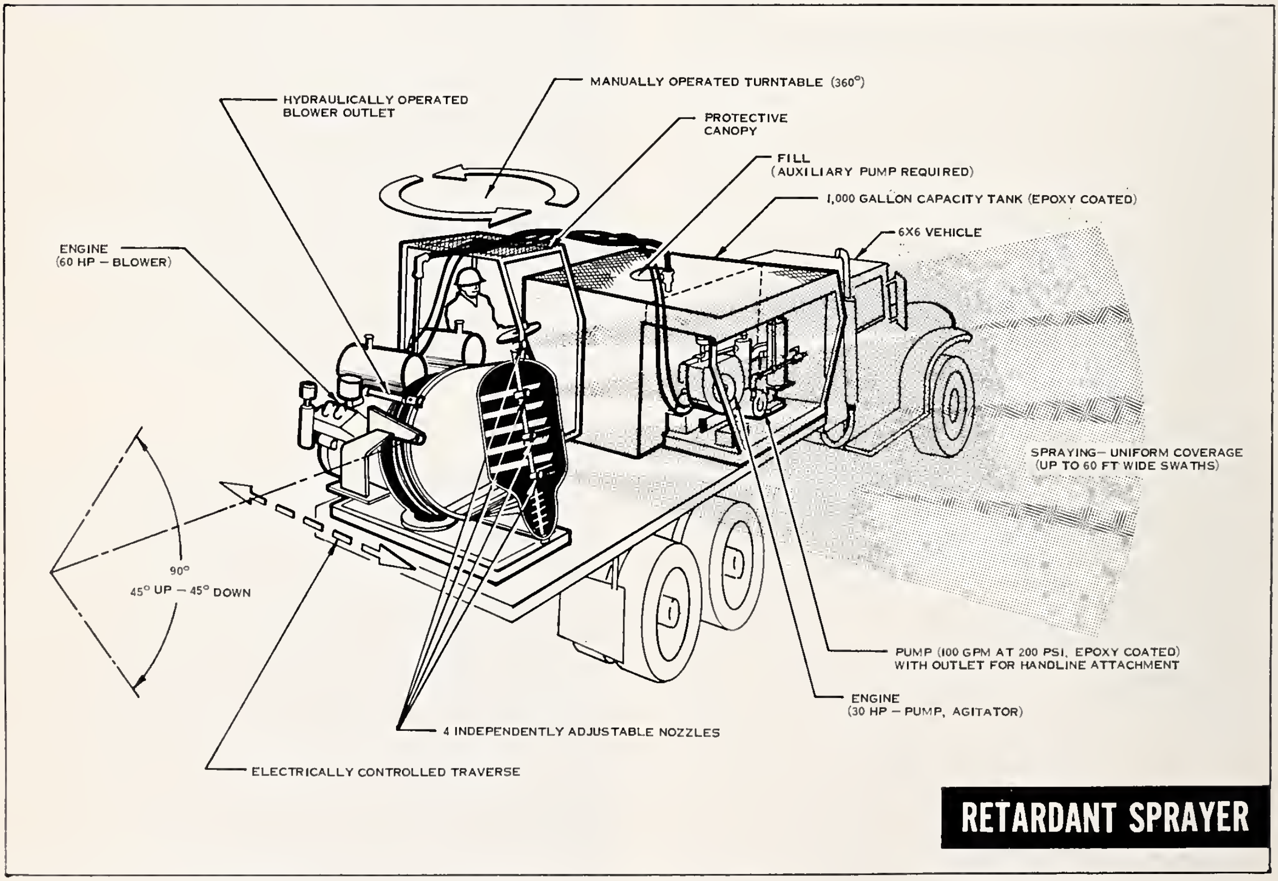
Retardant Sprayer—*Continued from page 4*

or maintenance have been encountered. Occasionally debris clogs nozzles during spraying, but it is easily remedied by cleaning the sediment chamber and by temporarily opening nozzles to flush them out. No further modifications are planned. To improve mobility, we intend to study the practicality of mounting the unit on a trailer for towing behind a bulldozer.

Though primarily developed for pretreating prescribed burn perimeters and high-hazard roadsides and for reinforcing control lines on wildfires, the unit has many other possible uses including:

1. Laying temporary retardant firelines in light, flashy fuels.
2. Suppressing fire directly by spraying water or retardants onto burning fuels. This can be done with the blower shut off.
3. Spraying water as an aid in mopup.
4. Applying many other chemicals including herbicides, insecticides, and fertilizers for other land management jobs.

The prototype unit cost $8,500. The cost of future units is expected to remain about the same.


MANUALLY OPERATED TURNTABLE (360°)
HYDRAULICALLY OPERATED BLOWER OUTLET
PROTECTIVE CANOPY
FILL (AUXILIARY PUMP REQUIRED)
1,000 GALLON CAPACITY TANK (EPOXY COATED)
6X6 VEHICLE
ENGINE (60 HP – BLOWER)
SPRAYING– UNIFORM COVERAGE (UP TO 60 FT WIDE SWATHS)
90° 45° UP – 45° DOWN
PUMP (100 GPM AT 200 PSI, EPOXY COATED) WITH OUTLET FOR HANDLINE ATTACHMENT
ENGINE (30 HP – PUMP, AGITATOR)
4 INDEPENDENTLY ADJUSTABLE NOZZLES
ELECTRICALLY CONTROLLED TRAVERSE
RETARDANT SPRAYER

U. S. FOREST SERVICE EQUIPMENT DEVELOPMENT CENTER
MISSOULA, MONTANA

Figure 2.—Schematic of retardant sprayer.

NEW SYSTEM FOR STORING AND MIXING FIRE RETARDANT

Los Angeles County Fire Department

A new demand-type system for storing and mixing fire retardant for air tanker use has been developed and installed by the Los Angeles County Fire Department at its base at the Hollywood-Burbank airport. According to Chief Keith E. Klinger, this system is the first such facility in the Nation and will increase the county's efficiency in the fast handling of retardant air tankers.

This new "clean" system provides bulk storage and handling of Phos-chek fire retardant, and reduces the number of men needed to handle the mixing from 10 to 1. Of course, additional men are needed to load the aircraft. Four planes can be loaded simultaneously at the Department's facility.

Battalion Chief Frank Hamp, the Department's equipment and development officer, designed the new facility. Two 32-foot-long bulk storage trailers (fig. 1), both with a capacity of 18 tons of powder, provide dry storage. Each trailer is equipped with an internal airslide and a compressor.

Air, at a pressure of 1-2 p.s.i., is introduced at the bottom of the tank (at the airslide), and the powder flows to the outlet in the manner a fluid flows. The Phos-chek is carried to the elevated mixing platform under a vacuum; two eductors are supplied with water from a stationary fire pumper. At this point the mixing is completed; 600 g.p.m. is produced. Under this system the quantity of mixed Phos-chek produced is limited only by the capacity of the pump and by the available water supply. The mixed retardants is stored in a 5,000-gallon tank until needed. Two pumps, capable of delivering 900 gallons of retardant per minute, feed the delivery system.

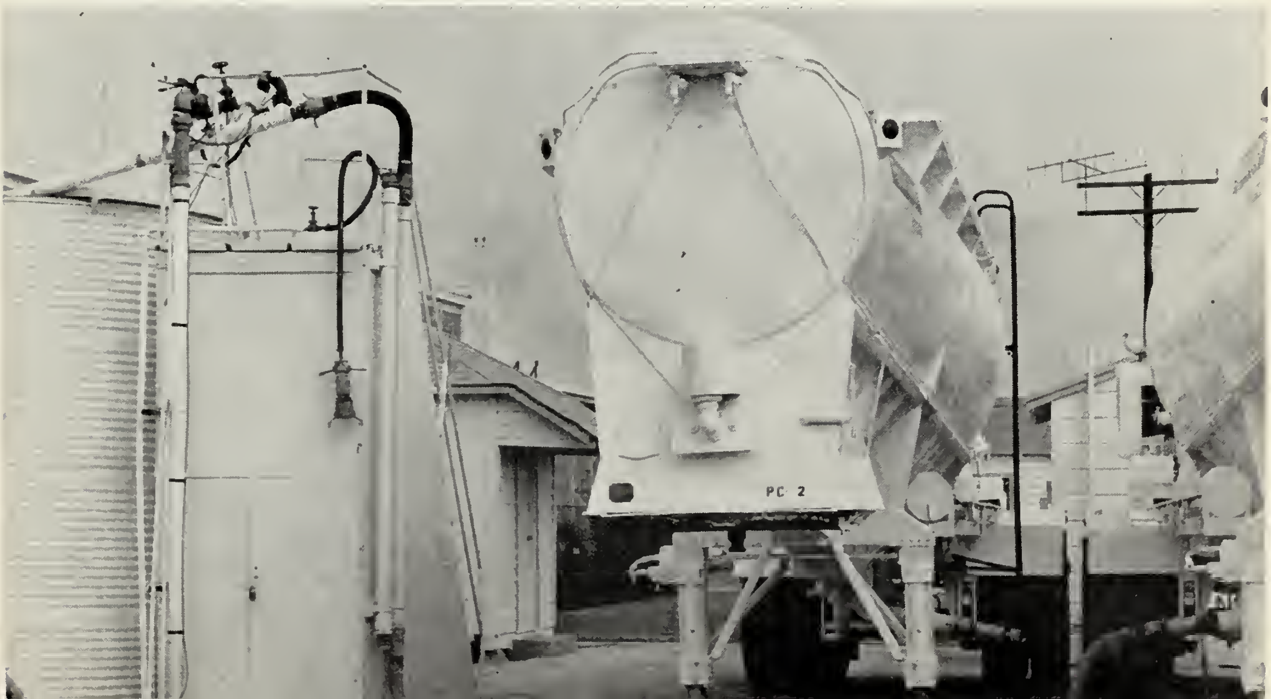
Unique features of the system permit one operator to control the quality of the finished product through a single valve. As retardant becomes needed, he activates the main control valve, which automatically increases the number of the pumper's revolutions per minute to a predetermined level to maintain the desired pressure.

On the delivery pumps, a waterflow microswitch is activated when the nozzles are opened at the aircraft, and the pump engines increase pressure automatically.

The new system alleviates the need for sacked retardant and for a system for opening and emptying the sacks. Its bulk storage and semi-automated mixing features lend themselves to the possibility that an entire mixing plant may someday be able to be picked up and easily trucked to an airfield; there it can supply aircraft at a nearby fire.

The County Fire Department has operated the mixing facility at the Lockheed airbase for 3 years. During the first 9 months of 1968, 234,900 gallons of retardant have been mixed and delivered.

Figure 1.—Large bulk storage trailers supply Phos-chek to mixing platform at left. Mixed retardents is stored in a 5,000-gallon metal tank, ready for loading into aircraft.



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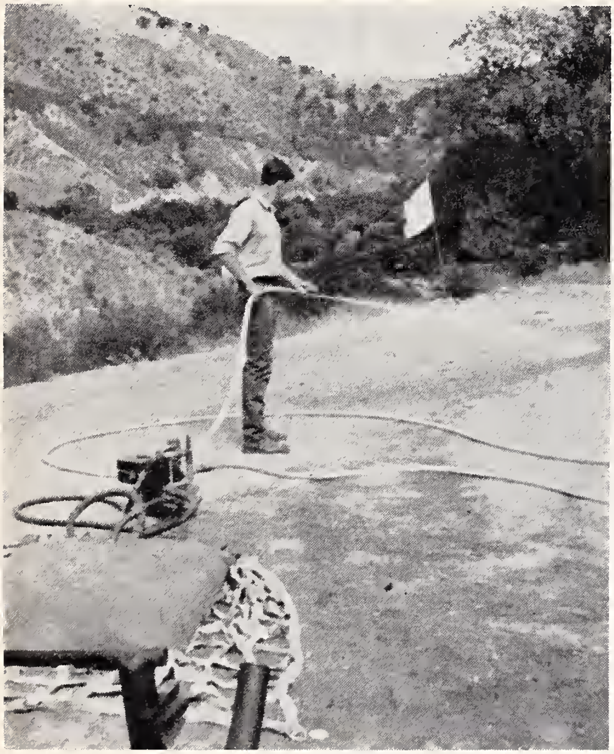

Portable Collapsible Tanks—*Continued from page 11*

2. Such a tank is easy to place in service on short notice without any special attachment to the helicopter.

3. It is easy to deliver to anyplace on a fire where a helicopter can maneuver within 30 feet above the ground.

4. It should secure more widespread use of water or retardants on a fire via helicopter.

5. Water or retardants delivered on a fire via a hose are more efficient and effective than when delivered by an airdrop.

Editor's note: The General Services Administration now stocks these collapsible tanks in five sizes with 50-, 100-, 150-, 250-, and 500-gallon capacity. The smaller (50-150 gallon) tanks are pillow-shaped as illustrated; the two larger tanks are pyramid shaped.

Figure 3.—The lightweight, portable pumps now available are ideal for use with the portable tanks. With positive displacement pumps, the bypass should be connected back into the tank overflow pipe to conserve water.

REMOTE WIND MEASUREMENTS

Many fire-danger stations now use the Ten-Minute Wind Counter to obtain windspeed measurements. However, some personnel may not be aware that when this device is used, the anemometer can be placed as much as 1 mile away. Thus, at stations where obstructions or other factors make onsite exposure of the anemometer unsatisfactory, the instrument can easily be placed at a more suitable location some distance from the station. Number 20 or 22 copperweld twin-conductor wire is satisfactory for connecting the anemometer to the counter. The voltage supplied to the counter should not be increased to compensate for the greater distance because damage to the anemometer contacts may result.

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A quarterly periodical devoted to forest fire control

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COVER—A typical lookout of 1912. Communication with headquarters or with other lookouts was by telephone or heliograph—if the sun was shining. For more current detection methods, see report on page 8.

(NOTE—Use of trade names is for information purposes and does not imply endorsement by the U.S. Department of Agriculture.)

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BUILDUP INDEX ANALYSIS—AID TO FIRE CONTROL?

PAUL H. HAGERTY, *Supervising Forestry Meteorologist*[1]
E. LOWELL CROOM, *Forestry Meteorologist*
ESSA Weather Bureau Office for Forestry

Man has long used numerical scales to solve his problems. Fire Control personnel are acutely aware that a simple solution permitting a quick appraisal of the fire-danger situation across a forested area by such a scale is nonexistent and is not even on the horizon. However, the National Fire Danger Rating System (NFDRS), introduced in 1963, presents a reasonable approximation of the cumulative effects of weather across a forested area.

This system has one common denominator, the "Buildup Index" (BUI), for relating and comparing situations across otherwise reasonably homogeneous forested areas. The Buildup Index has been defined as "a number expressing the cumulative effects of daily drying factors and precipitation in fuels with a 10-day timelag constant." It is an expression of the moisture conditions of the heavier fuels—those that require 10 drying days to lose approximately two-thirds of their moisture above equilibrium. As the moisture content decreases, the BUI increases—indicating an increase in the severity of burning conditions. Therefore, the BUI is essentially a numerical value indicating the moisture content of the heavier fuels of a timbered region as influenced by weather.

An examination of the spread-phase tables of the NFDRS confirms this belief that the BUI depends totally on weather. The variables—dry-bulb temperature and atmospheric moisture (the latter is expressed as wet-bulb temperature, relative humidity, or dewpoint)—are the primary determining parameters. The importance of antecedent precipitation has been acknowledged in the original definition, and the exact influence can be seen by referring to the Buildup Index Recovery Table of the Spread Phase Tables of the NFDRS. By doing so, it is easy to see that the BUI can be determined by using observations from urban or nonforested areas as easily as from prime timberland locations if the bookkeeping of drying factors are recorded daily.

Prior to the development of the National Fire Danger Rating System, many danger rating systems were in use. The Lake States and Central States systems were sensitive to the number of days since rain. Fire-weather forecasters plotted precipitation charts daily and ascribed the proper number of days since rain for each reporting station. Analysis of the days-since-rain chart pinpointed areas of concern. In short, lack of rainfall was the forecaster's main criterion for labeling "hot" areas or potential trouble spots. After some experience forecasting for the NFDRS, analysis of BUI values seemed logical to the forecaster for the same reason.

Regional analysis of BUI values can be accomplished once a base map is established to facilitate plotting of the data. The observational input for determining BUI can include regular weather reporting stations as well as observations from the fire-weather station. Routine daily observations from forested locations are taken at the basic observation time, generally at 1 p.m. in the Southeastern States. These observations are an important supplement to the routine Weather Bureau observation input to the fire-weather forecaster. The number of reporting points available to the forecaster varies from State to State. However, in all States the number should be sufficient to assess the situation and to describe the range of BUI values in enough detail to permit decisions on operations, both by the forecaster and a fire control headquarters.

At the ESSA-Weather Bureau Office for Forestry at the Georgia Forestry Center near Macon, Ga., daily samples are gathered routinely from 13 points throughout the State. However, the maximum BUI, if greater than the BUI, at the regular reporting station within each forested district, is added to the routine report. These values are normally sufficient for a representative BUI analysis, but 17 hourly weather reporting stations in and adjacent to the State can be used to complete the analysis if desired.

---

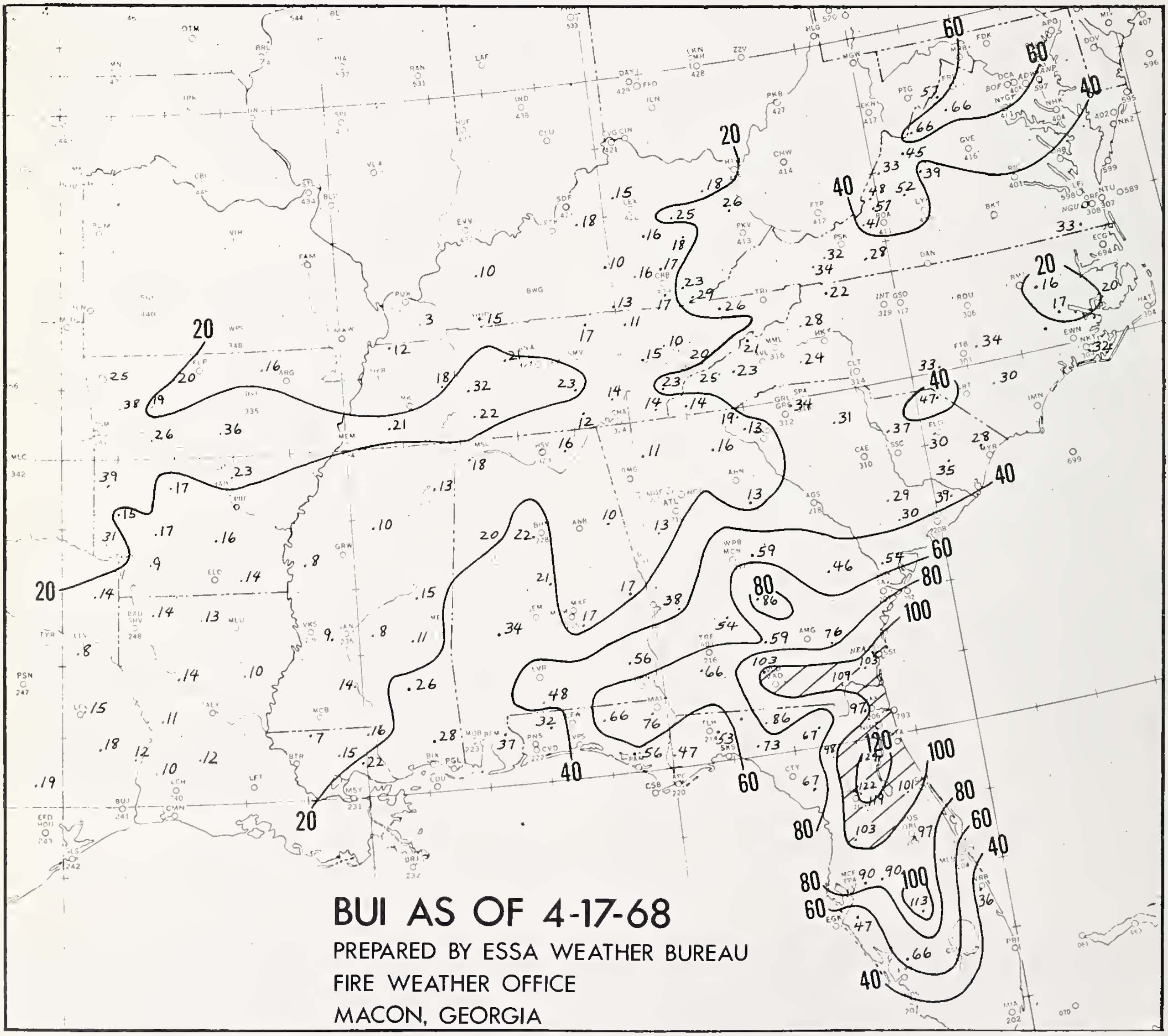
[1] The authors are U.S. Weather Bureau, ESSA, employees stationed at the Georgia Forestry Center, Macon, Ga., and are cooperators in the U.S. Forest Service Forest Fire Meteorology Project. Mr. Hagerty also serves as Coordinator, Weather Bureau Southern Region Forestry Meteorology Programs.

In response to requests by concerned groups, BUI analysis was initiated by the Macon Fire-Weather Office in 1966. It was necessary to obtain the cooperation of the ESSA-Weather Bureau fire-weather forecasters serving the Southern and Southeastern States and the forestry interests of individual states. Essentially, the Macon office became the clearinghouse and analysis center for data samples collected weekly from the individual fire-weather offices. One such analysis (fig. 1) permits further insight into the procedure and the results.

The analysis is a static picture of the BUI situation on a given date. However, by superimposing the expected precipitation over the analysis, both as to amount expected and time of occurrence, an estimate of the easement, intensification, or little change in the fire danger rating can be projected. The ESSA-Weather Bureau 5-day outlook charts are quite useful for this type of interpretation.

Analysis of the plotted BUI values is helpful to fire control in assessing the burning potential and permits easy presentation of the situation

(Continued on page 7)



BUI AS OF 4-17-68
PREPARED BY ESSA WEATHER BUREAU
FIRE WEATHER OFFICE
MACON, GEORGIA

Figure 1.—An analysis of buildup index values received from timberland locations in 13 Southern and Southeastern States. Note the maximum values in southern Georgia and northern Florida.

REDUCING THE INCIDENCE OF CHILDREN AND MATCHES FIRES[1]

K. R. GOINGS, *Fire Prevention Officer*
California Division of Forestry

Children and matches are a serious risk in the Division's primary responsibility areas. Children utilizing various sources of ignition, mostly matches, are responsible for over 20 percent of the man-caused forest fires in California each year. These fires are commonly referred to by the fire services as "C & M" fires. There has been no significant decline in these types of fires during the past 20 years despite the aggressive Fire Prevention Information and Education Program that has been directed toward them.

Recent studies have revealed that "C & M" fires become a problem at an age younger than that at which fire prevention efforts have been directed toward in the past. (table 1).

TABLE 1.—*"Children Fire" starts, by five age groups*[2]

Age	*Percent of Fire Starts*
Under 5	12
5 to 7	34
8 to 10	28
11 to 13	16
14 and over	10

[2] Folkman, William S., "Children With Matches" Fires in the Angeles National Forest Area: USDA Forest Serv. Res. Note PSW-109, Berkeley, Calif., 1966, p. 2.

Good Information Alone Cannot Change Attitudes

Since the conception of Smokey Bear over 20 years ago, we have been very successful in getting the message about the dangers of fire to the public, but the information received does not do a fire prevention job by itself. The well-known "Only you can prevent forest fires" and many other such phrases have gotten the information to nearly every person in the land; however, it has evidently failed to convert the attitude of many people concerning their individual responsibilities to reduce the incidence of wildland fires.

This "hard-to-influence" attitude phenomenon is not peculiar to fire prevention. It is evident in other campaigns, such as those for the prevention of accidents and diseases.

Butte Ranger Unit personnel are attempting to break through this attitude barrier by educating the very young child about fire, the cause of fire, and how unwanted fire can be prevented.

By educating the child at the earliest age possible, and by proper followup, the fire prevention information hopefully will be retained as he or she passes through each successive age group. Also, the child may, in his innocence, very effectively act as a second conscience to many of these potential fire starters who are older than he is by parroting fire prevention messages to them. Consequently, with this procedure you are getting the information to many age groups through the young child, and you are also creating within him an everlasting, favorable fire prevention attitude. Thus, it has hoped that good fire prevention practices will become deep-rooted habits.

Establishing a Fire-Prevention Program

After accepting the foregoing as a solution to the children and matches forest fire problem, the Butte Ranger Unit Fire Prevention Officer in charge of the Information and Education program contacted Dr. James F. Lindsey, principal of the Aymer J. Hamilton Laboratory School at Chico State College, Chico, Calif. One of the basic functions of this Lab School is experimentation and innovation in teaching and teacher education.

After hearing an explanation of the Division's problems and the proposed solution, Dr. Lindsey became energetically enthusiastic about assisting in the planning and development of the methods which would serve as a vehicle for attaining the desired solution.

Teaching The Teachers

The first step was in teacher education. In this case, it was teaching the lay-teacher Fire Prevention Officer how to use some of the most up-to-date teaching techniques. This was the first encounter that that Lab School had ever had in teaching lay people professional techniques of early childhood instruction. The 6 hours of classroom instruction proved rewarding for Dr. Lindsey and his staff because the Fire Prevention Officers learned the techniques with surprising rapidity.

---

[1] Adapted from California Fire Prevention Notes, October 1968.

The backbone of the instruction consisted of a familiarization with team teaching. In team teaching, children are separated into very small groups of between 5 and 10, and each group is taught a subject according to their speed of learning.

Dr. Lindsey and his staff covered many "do's and don'ts," and some of the more important methods and techniques of presentation that the Lab personnel introduced to the Fire Prevention Officers follow:

1. Save your "attention-getters" until last. Arrange your presentation so that each successive portion is more interesting, more exciting, or more motivating than that which preceded it. Do not, for example, begin with the most interesting part of the presentation—such as Smokey Bear, a fire truck, or a flashy demonstration. For a group of youngsters, your badge, nameplate, and uniform provide enough contrast with the everyday humdrum of a young child's life to be an initial attention-grabber. It would be best if the group of youngsters could not even guess what was going to happen next; if they could, some of them could be distracted.
2. When dealing with very young children, never try to hold their attention any longer than 10 minutes with any gimmick or phase of your presentation.
3. The most important item for holding a group of youngster's attention for longer than 2 or 3 minutes is to keep your group small. Encourage the group to teach themselves by individual, active participation. It is amazing how little help, other than praise for correctly channeled thinking, that the group needed to learn all of the right answers.
4. Avoid all distracting situations. Never allow the students to anticipate what gimmick is going to be used next. For example, do not allow the children to see the projector, some unusual display case, the firetruck, other firefighting equipment, or a glimpse of Smokey Bear before these things are made part of the presentation. If you fail to do this, there is a good chance that many youngster's minds and imaginations will be diverted way ahead of you to the more exciting item, and your message will not even be heard, much less understood.

The First Operational Test

On February 9, 1968, five Fire Prevention Officers (four group discussion leaders and an observing leader) walked into a kindergarten class in the small community of Palermo, Calif., for the first operational attempt at using modern teaching procedure to teach fire prevention to the very young.

The class was divided into small groups by the teacher. Each group sat in a semicircle around a Fire Prevention Officer, who was sitting, as were the students, in a miniature chair for knee-to-knee, eye-to-eye contact, commonly referred to by interrogators as the essential periphery of awareness (fig. 1). Only five basic points were stressed during the conference leader-type discussion that ensued.

1. Do not play with matches.
2. If you find matches at home, give them to a parent.
3. If you are on your way to school and find matches, give them to the busdriver or school teacher.
4. If you see a younger child with matches, take them away and give them to an adult.
5. If you see a wildland fire, have an adult call the fire department right away.

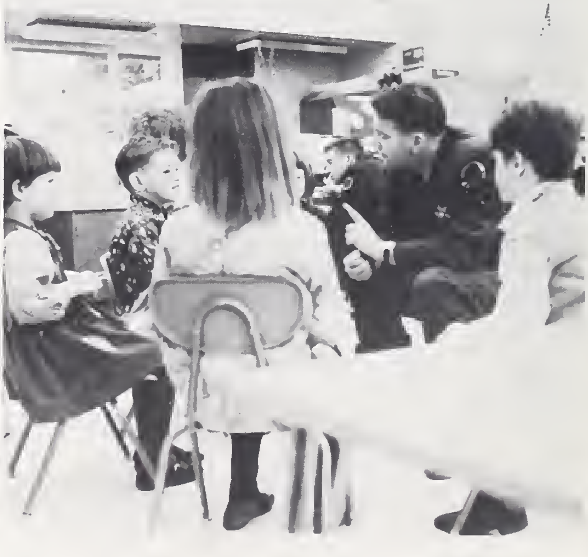


Figure 1.—Optimum effectiveness is achieved through small groups, with the group leader at the childrens' eye level.

The four discussion leaders stressed these points for about 8 to 10 minutes. The Fire Prevention Officer leader furnished only information for thought and guidance. In every case, correctly channeled thinking was obtained from each respective group through their own, individual active participation.

When the observing leader was aware that the discussion leaders' uniform, badge, nameplate, patch, and questions were beginning to exceed the interest span of the youngsters, he advised all of the groups that a motion picture film was about to be shown. On this cue, the group leaders distributed Smokey Bear pins and praised their individual group members for their accomplishments (fig. 2).

The motion-picture film was a color fire-prevention film which lasted for about 10 minutes.

When the film was over, the observing leader, someone who was new to the individual groups, spent about 5 minutes asking the entire group what they learned during the session. The favorable, enthusiastic response was terrific. Then, as a grand finale, Smokey himself came in to repeat the inquiry as to what the group had learned and to express his appreciation for what they had learned.

Only Time Will Tell

The first operational phase of the progressive teaching of fire prevention to youngsters has been completed at 11 kindergarten classes in the Oroville area. Butte Ranger District personnel are now planning to give similarly taught monthly followup programs. The use of regular fire control personnel to fulfill team assignments will be encouraged in the followup programs.

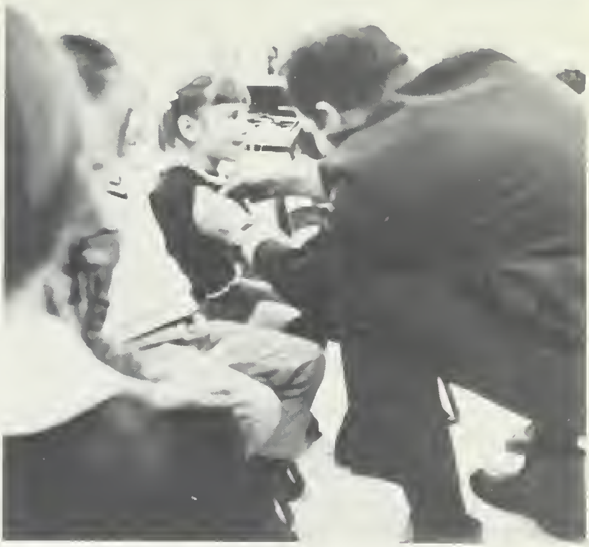


Figure 2.—Group leaders concluded the discussion by praising each child and pinning on a Smokey Bear pin.

The results of this training will probably not be very evident until this type of instruction has been practiced for several years.

However, it is the author's belief that a milestone has been reached in our attempts to reduce the incidence of fires caused by children and matches.

Buildup Index—*Continued from page 4*

across forested areas so that all factors can be weighed in determining needed action. Also, briefing of concerned but technically unfamiliar officials is possible.

Fire control chiefs can brief high-level State officials on the situation across a given State and can highlight the more critical areas so these officials can consider closing woods, imposing burning bans, or increasing TV or radio spot announcements on fire prevention in "hot" areas.

However, other officials must know the situation across a combination of States. Researchers documenting wildfires have expressed a need in this area in order to establish degrees of readiness for equipment and manpower. Coordinators of Forest Fire Compacts can use the analysis as an aid in assessing the relative situation among member States. If the BUI can be considered as a partial expression of the potential for large fires, then the analysis can be an important tool in making decisions associated with coordinating manpower and equipment actions resulting from affiliations and obligations of Compacts. Also, in this respect, regional fire control officials who must make interstate decisions should find the analysis a definite aid in fire control preparedness.

The future is bright in this area of BUI analysis. It has been suggested recently that

(Continued on page 15)

AN OPERATIONAL TEST OF AN INFRARED FIRE DETECTION SYSTEM

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Intermountain Forest and Range Experiment Station

An infrared (IR) fire detection system, developed by Project Fire Scan personnel at the Northern Forest Fire Laboratory, was operationally tested during the 1967 fire season. The system, installed in a Convair T-29B aircraft (fig. 1), included three items not found in other IR systems:

1. A rapid film processor
2. A target discrimination module (TDM) which automatically marks hot targets on the film, and
3. A Doppler radar navigation system which provides accurate, instant information on an aircraft's position.

This operational test was designed (1) to determine how well an IR system could detect latent forest fires under natural conditions, and (2) to investigate problems associated with identifying targets on the IR imagery, locating their position on a map, and quickly dispatching the information to the fire control organization.

For this test, a study area covering 41 National Forests in Forest Service Regions 1, 2, 4, and 6 was established. Personnel of each Forest helped verify the IR-detected targets and provided information about fires detected by conventional methods to help determine whether the IR system had missed any fires.

Forests were ranked by their lightning-fire frequency to help in the selection of each mission area. The Weather Bureau's radar at Missoula, Mont., and the radar net centered at Salt Lake City, Utah, provided information on thunderstorm activity in the study area. Using this information, missions were scheduled over the areas affected that had the highest probability of lightning fire occurrence.

Figure 1.—Convair T-29B aircraft used for fire detection missions.

All missions were flown at night about 15,000 feet above the terrain. After each mission was completed, the imagery was interpreted; the legal locations of possible fires and campfires were dispatched to the Forests at about 0700 hours. During July and August, 21 missions, averaging 2.4 million acres, were flown. Unfortunately, we could not fly for about 3½ weeks (July 27 to August 21) because of an aircraft engine failure; half of the planned missions were eliminated.

Imagery recorded from flights included 1,434 TDM marks. The number interpreted as hot targets was 601 (fig. 2). The remaining 833 were interpreted as false alarms. Shortly after the test flights began, we found a design error in the TDM that caused it to mark items in addition to hot targets. Since completion of the study, the TDM system has been redesigned to reduce, if not eliminate, the problem.

Of the 601 hot targets, 213 (35 percent) were interpreted as wildfires (fig. 3). Some were later confirmed as other types of hot targets (fig. 2). Most of the remaining 388 (65 percent) hot targets were incorrectly identified because of incomplete ground intelligence. Accuracy of identification should be nearly 100 percent if the location of camping areas, hot springs, or scheduled slash burnings is available to the interpreter.

Fifty-five reported fire targets could not be found or identified on the ground. These unconfirmed reports caused suppression units to lose valuable time in unsuccessful search. Twenty-one of these 55 fires probably burned out naturally. Unfortunately, no remains could be found later to verify this hypothesis; however, lookouts reported flareups at locations of two of the unconfirmed targets. The remaining 34 unconfirmed targets could have been small fires that went out naturally or false alarms caused by the TDM and incorrectly identified by the interpreter. Future testing with the redesigned TDM should indicate the magnitude of the unconfirmed report problem.

---

[1] Research Forester, Bitterroot National Forest, Darby, Mont. This article is based on work performed when the author was Study Leader in charge of the Project Fire Scan infrared lightning fire patrol evaluation. He was then stationed at the Northern Forest Fire Laboratory, Missoula, Mont.

Of the 388 hotspots identified as miscellaneous targets, two were later confirmed as fires. Both were beside a road and were identified by the interpreter as campfires.

During the patrol season, 134 fires, in various stages of control, were scanned (fig. 4). When control action starts, the amount of radiant heat available for detection decreases until the fire is extinguished; therefore, only unmanned fires were considered in the analysis to determine success of IR detection.

Forty of the 134 fires (30 percent) detected were unmanned when they were scanned. The TDM detected and marked 23 of these 40 fires (58 percent). Five others (12 percent) were recorded on the film, but the TDM did not alarm on them. Redesign of the TDM increased its sensitivity, and we hope these marginal targets will activate it.

Although success of IR detection was lower than anticipated, it compared favorably with conventional detection. At the time the 40 fires were scanned, only 14 (35 percent) had been detected by conventional methods versus 23 (58 percent) for IR. IR detected 14 fires before conventional methods. Several of these fires could have become serious, but early detection by IR prevented such occurrences.

Accurate location of fires is necessary so that suppression units may find them quickly. The interpreter located detected targets to one-

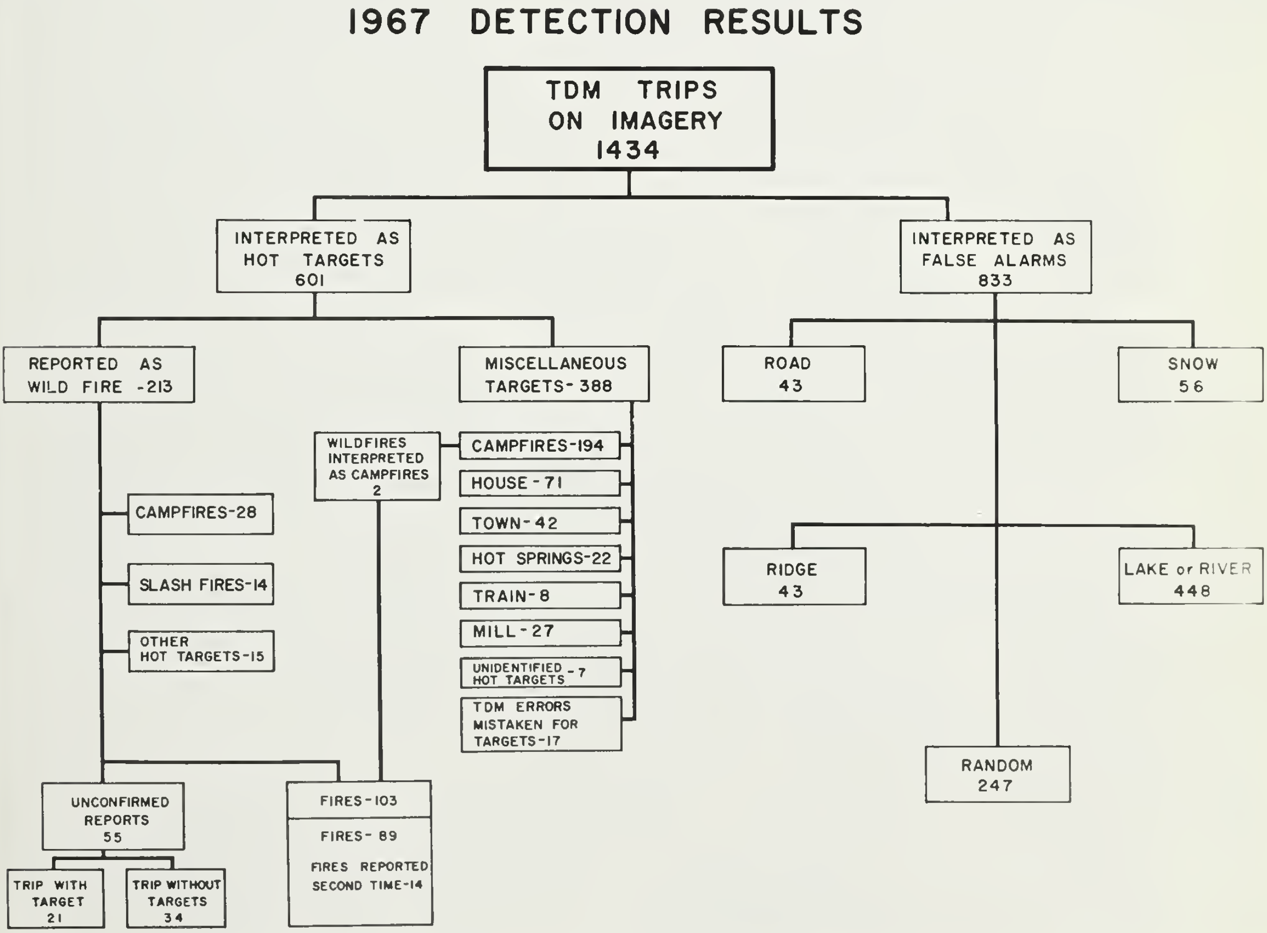
1967 DETECTION RESULTS
TDM TRIPS ON IMAGERY 1434
INTERPRETED AS HOT TARGETS 601
INTERPRETED AS FALSE ALARMS 833
REPORTED AS WILD FIRE -213
MISCELLANEOUS TARGETS-388
ROAD 43
SNOW 56
WILDFIRES INTERPRETED AS CAMPFIRES 2
CAMPFIRES-194
HOUSE-71
TOWN-42
HOT SPRINGS-22
TRAIN-8
MILL-27
UNIDENTIFIED HOT TARGETS -7
TDM ERRORS MISTAKEN FOR TARGETS-17
CAMPFIRES-28
SLASH FIRES-14
OTHER HOT TARGETS-15
RIDGE 43
LAKE or RIVER 448
RANDOM 247
UNCONFIRMED REPORTS 55
TRIP WITH TARGET 21
TRIP WITHOUT TARGETS 34
FIRES-103
FIRES-89
FIRES REPORTED SECOND TIME-14

Figure 2.—Summary of imagery from operational test flights in 1967.

sixteenth of a section (a 40-acre block) with the aid of ½-inch-to-the-mile Forest Service maps. To check the accuracy of the interpreter's location of a fire, we compared it with the location shown on the Individual Fire Report compiled by Forest personnel. This check showed that 73 percent of the fires were located within one-fourth mile of the location shown on the official Individual Fire Report; 90 percent were located within one-half mile.

The tests in 1967 demonstrated that this prototype system could detect small wildland fires and that the information could be made available to the fire control group when it was most valuable. An improved system now being developed will increase detection success, reduce the false alarm rate, and provide better IR image detail for more precise fire location.

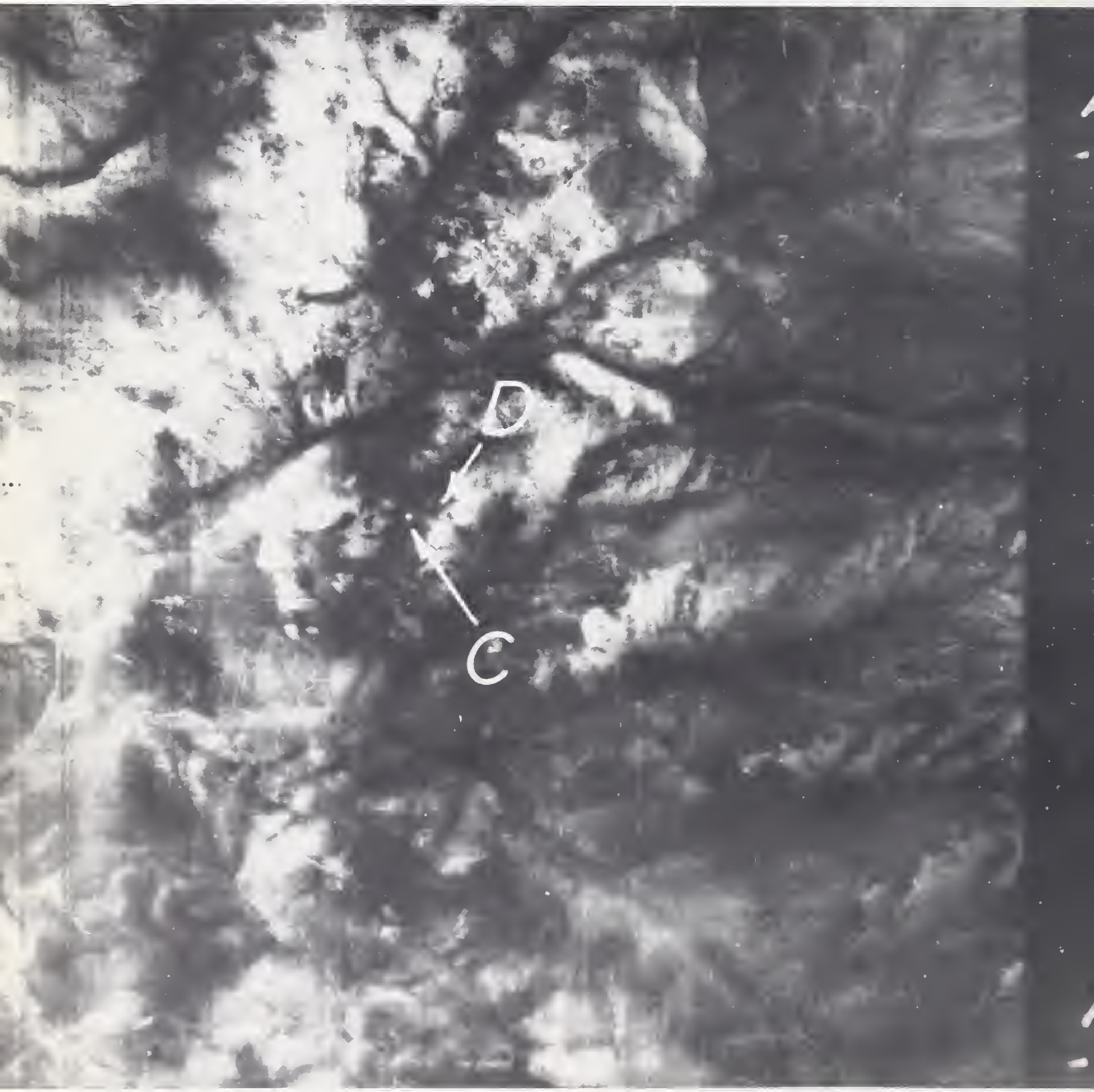

Figure 3.—Infrared image at 12,000 feet over terrain covers about 40 square miles. A, Inserted by the navigation system, these marks show 5-mile intervals along the track; B and C, automatically inserted by the TDM to indicate the presence of a fire target; and D, latent forest fire.

DETECTION SUCCESS

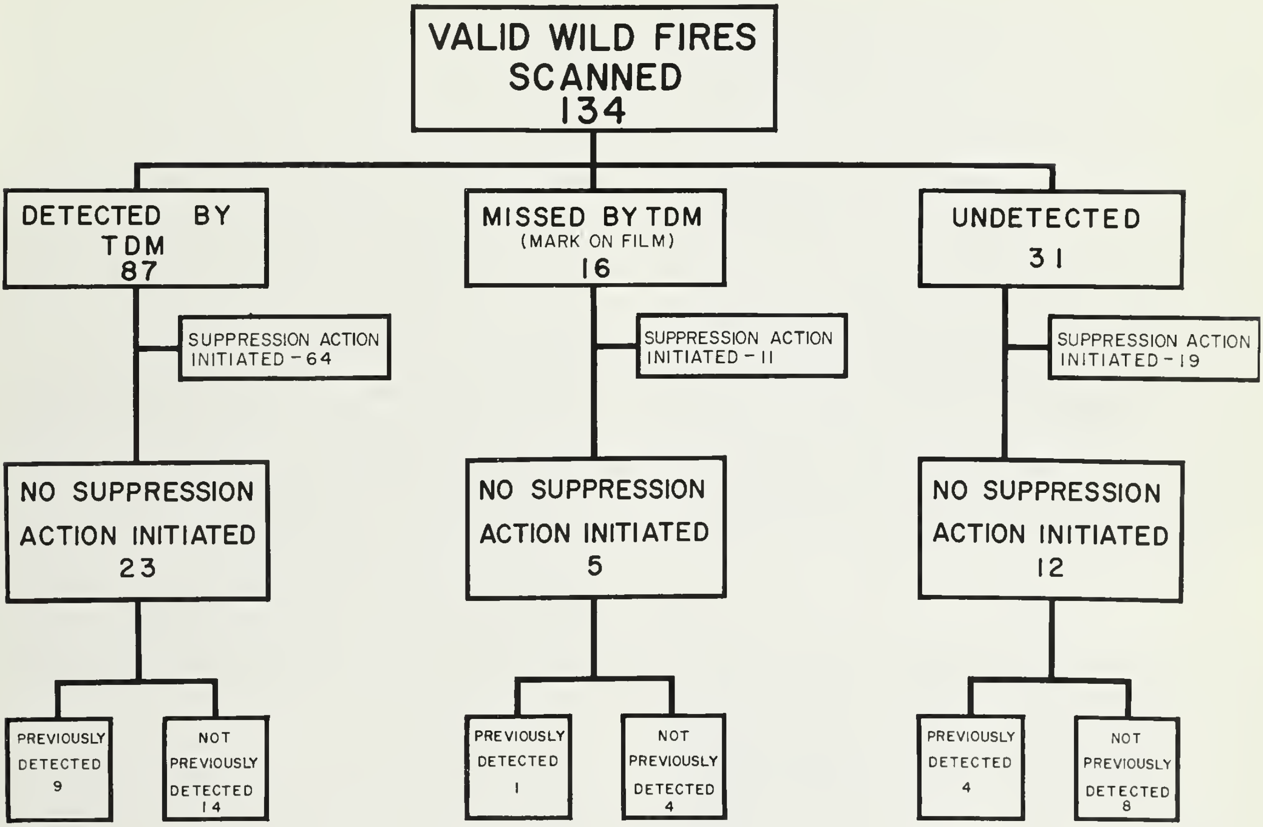
VALID WILD FIRES SCANNED 134
DETECTED BY TDM 87
MISSED BY TDM (MARK ON FILM) 16
UNDETECTED 31
SUPPRESSION ACTION INITIATED - 64
SUPPRESSION ACTION INITIATED - 11
SUPPRESSION ACTION INITIATED - 19
NO SUPPRESSION ACTION INITIATED 23
NO SUPPRESSION ACTION INITIATED 5
NO SUPPRESSION ACTION INITIATED 12
PREVIOUSLY DETECTED 9
NOT PREVIOUSLY DETECTED 14
PREVIOUSLY DETECTED 1
NOT PREVIOUSLY DETECTED 4
PREVIOUSLY DETECTED 4
NOT PREVIOUSLY DETECTED 8

Figure 4.—1967 detection success.

DUMP TRUCKS AS A PORTABLE WATER SOURCE FOR HELICOPTER PICKUP

Jack Shero, *District Administrator, Kelso District*
Lloyd Clark, *Assistant District Administrator, Kelso District*
Department of Natural Resources, State of Washington

Helicopters with buckets suspended from their cargo hooks are being used effectively in wildfire suppression.

One requirement for efficient use is a nearby source of water of sufficient quantity and depth, and in a location where a suspended bucket can be dipped. There are many areas in the forest where there is enough water in the small streams, but the water is not deep enough. For two reasons, it seemed advantageous to try to find a way of obtaining a useable supply of water or retardant in such areas. First, the minimization of delivery time would provide more water on the fire; second, the total fire bill would be substantially less.

One way to provide such a spot is to set up a large plastic or canvas sump or tank and keep it filled using a pump. While these sumps or tanks have been used successfully, they are not commonly available, and are usually stored somewhere other than where they would be needed in an emergency. Also, they can be bulky and difficult to handle.

A more readily available substitute was needed. A check indicated that there were quite a number of large dump trucks available in most of the logging areas in western Washington.

In July 1968, tests were conducted in the Kelso District of the Department of Natural Resources, using these dump trucks as a portable source of water for pickup by helicopter.

The tests were conducted under simulated fire conditions in timber in the Whitten Creek drainage of the South Toutle River in Cowlitz County in southwestern Washington. A turbocharged Kaman H-43 helicopter and a 10-yard dump truck with the bed lined with polyethylene were used for the tests (fig. 1). The helicopter has a maximum allowable gross weight of 7,750 pounds (exterior load) (U.S. Air Force manual.) The weight of the aircraft including fuel and pilot is 4,900 pounds, leaving a load carrying capacity of 2,850 pounds. A washtub-type monsoon bucket 29 inches deep and with a 250-gallon capacity was used. The bucket is slung on wire ropes approximately 8 feet below the aircraft.

Suggested rules for setting up a dump-truck or retardant supply for helicopter pickup follow: Preparation—Use a dump truck with a capacity of at least 10 yards (approximately 2,000 gallons). Line the box with a large sheet of polyethylene, and tie down all loose edges to keep them from whipping with the downdraft from the rotors. Place the dump-truck in a cleared area, if possible, on a rise. Point the rear of the truck into the wind and downhill if possible. Be sure there is adequate clearance for the rotors and enough runway for the helicopter to build up flying speed. A cleared area (with a minimum radius of 100 feet) for landing the helicopter should be available nearby for refueling and maintenance. Wet down the area around the water pickup source to minimize flying debris and dust.

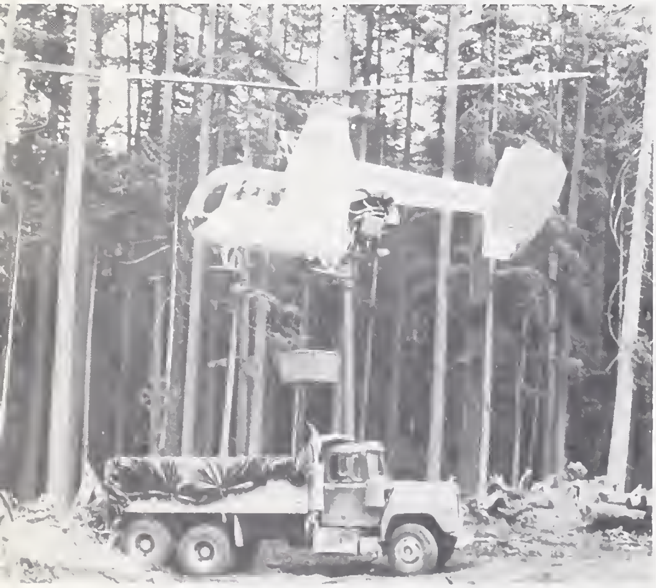

Figure 1.—A helicopter prepares to fill its bucket from a dump truck. Conversion of the truckbed to an emergency water tank is quickly done with a large plastic sheet.

Fill the truck with a volume pump. Gelgard or other short-term retardant or a detergent can be added, if desired, with the use of a field chemical mixer as the truck is being filled (approximately 12 pounds of Gelgard for each 1,000 gallons of water. A dye or coloring agent should be added to help the pilot see where he made previous drops. The truck can be kept filled while the helicopter is in flight. If a spare tire is mounted on the cabguard of the truck, it should be removed.

Ground Control.—A trained signalman should be on the scene to assist the pilot in loading the bucket from the truck. All signalmen should know the standard hand signals used at heliports and similar facilities. The signalman should wear a hardhat with a chinstrap because of the strong wind caused by the downdraft of the rotors. He should also wear goggles while working near the helicopter. All unnecessary personnel should be kept away from the area.

Some industry officials who witnessed the tests were so impressed that they volunteered to have each of their dump-truck beds lined with a folded piece of polyethylene. And dump-trucks were used quite successfully in fighting a slash fire on private land in October 1968.

LIQUID RETARDANT CONCENTRATES—A REPORT ON OPERATIONAL USE

DUANE W. MYLER, *Regional Air Officer, Region 8*

The Southern Region has used liquid phosphate concentrates for mixing retardant for aerial application for 6 years. In 1962, a trial operation was initiated to test the feasibility of air tanker use in the Southeast. Because it was a trial program with an uncertain future, a large expenditure for the mixing equipment, storage tanks, and other facilities required for the dry powder retardants then in common use was not justified. Therefore, attention was directed toward a liquid ammonium phosphate fertilizer manufactured by the Tennessee Valley Authority. The liquid would permit the retardant solution to be easily mixed in the air tanker as needed, and elaborate and costly equipment and facilities would not be required (fig. 1). Analysis of the liquid phosphate by the Macon, Ga., Fire Laboratory indicated it was as effective a retardant as the dry salt DAP or MAP being used elsewhere.[1] The 1962 spring fire season was brief and the fire load was light; therefore, results of the air tanker trial were inconclusive. Therefore, it was decided to continue the project to gain more experience.

When the 1963 fire season started, the Region was better prepared for an air-tanker operation. More storage tanks (Air Force surplus refueling units) were acquired, and larger pumps for loading were available.

The 1963 spring fire season rapidly developed into the worst since 1942, and the air tanker trial project quickly became a full-scale attack operation. By March 31, four B-26 air tankers were flying on Region 8 fires. All available retardant was soon exhausted and wet water had to be temporarily substituted. More storage tanks were acquired from the General Services Administration on an emergency priority. Also, the Tennessee Valley Authority cooperated by expediting delivery of retardant. And a PB4Y2 arrived from the West to bolster the air-tanker attack force. Initial attack with the retardant on the smaller fires provided almost 100-percent effective containment until ground crews arrived. In a few cases, air tankers were actually credited with full control. Even on larger fires, the liquid concentrate was extremely effective. In a few cases, attempts were made to cut off the head of hot, fast-rolling, project fires. Little success was achieved under these conditions due to spotting and the inability to build enough line ahead of the fire in a brief enough time. However, it was obvious after the fire was controlled that the retardant was extremely effective—the drop areas were easily identified as unburned islands of fuel. This was well established on a number of fires in the southern Appalachians and in Arkansas.

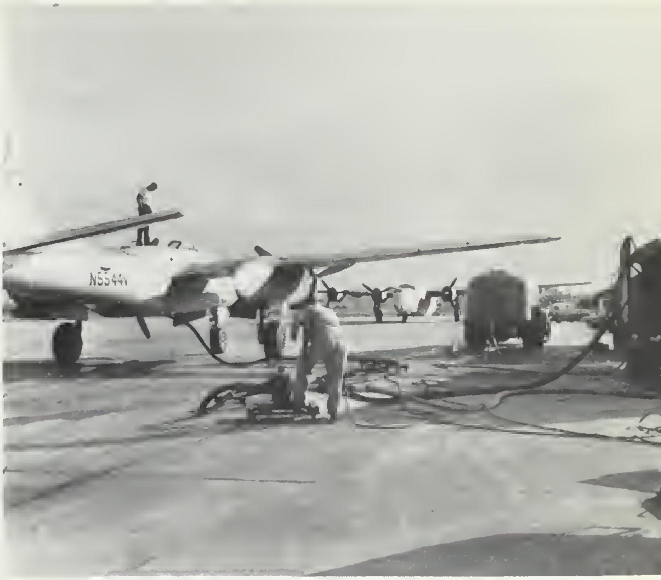
Figure 1.—The Knoxville, Tenn., air tanker base during the early days of air tanker use in the Southern Region. With liquid concentrate retardants, base facilities need consist of little more than a water source, concentrate storage tank hoses, and a pump to load the aircraft.

In the fall fire season, extreme conditions occurred again. Arkansas was in the third year of prolonged drought, and an emergency air tanker base was quickly established at Fort Smith. By this time, tanker crews and the lead-plane pilot were becoming more proficient with the use of liquid concentrate and in overcoming its basic drawback—its invisibility from the air. This was not a problem on initial attack; it occurred only during indirect line-building on larger fires. Lead-plane pilots soon found it was not too difficult to keep track of the drops by checking terrain features. Small gaps that did occur were not hard to plug.

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[1] Johansen, R. W., and Crow, G. L., Liquid Phosphate Fire Retardant Concentrates, Fire Control Notes V. 26, No. 2, pp. 13-16.

Since tanker and lead-plane pilots were all experienced in Western firefighting and in the use of thickened retardants, some were pessimistic about the liquid concentrate unthickened fire retardant. However, by the end of the 1963 fall season, all were enthusiastic.

As a result of the successes attained during the 1963 fire season, the trial air-tanker project emerged as an operational program. Since that time, Region 8 has established permanent air tanker facilities at Knoxville and Tri-City, Tenn., Fort Smith, Ark., and Weyers Cave, Va. (fig. 2).

In 1968, as a result of very critical fire conditions which developed in Florida, an emergency tanker base was also established at Deland, Fla. The first load of retardant was flown from the base 1½ days after work started, utilizing emergency trailer equipment furnished by the State of Florida, and the base was fully operational in 2½ days. The establishment of this base received wide publicity in the local newspapers, and on television and radio. Consequently, fire occurrence declined drastically and far less use was made of the tankers during the rest of the season. (Debris burning is the major cause in this area.) A typical report of the limited use, however, came from St. Regis Paper Company people—"We could not have stopped the fire short of 2,000 acres without the tankers; as it was, we held it to 80 acres." Region 8 will continue a trial project in cooperation with the Florida State Forest Service.

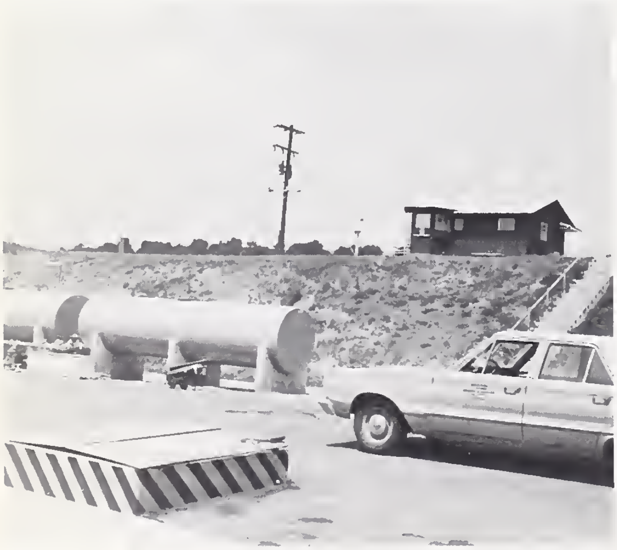

Figure 2.—A view of the permanent retardant base at Knoxville, Tenn., showing dispatch building and two of the three concentrate storage tanks.

Based on 6 years' experience utilizing the liquid concentrate fertilizer as a fire retardant, Region 8 has reached the following conclusions.

1. The retardant penetrates heavy canopies very effectively, not only coating the canopy itself but also the ground fuel.
2. Where thickened retardants tend to coat only the top layer of heavy matted fuels, such as grass, pine needles, etc., the unthickened solution tends to run around, down, and through the fuel, thereby restricting the tendency of the fire to creep under surface fuels.
3. The unthickened material flows around aerial fuels and has more of a tendency to coat all surfaces of the fuel, rather than just the one side.
4. Liquid concentrate is more flexible than dry-prepared retardants because the formulation can be varied at will with no detrimental effects. The water can be reduced in drops prepared for heavier fuels, thereby increasing salt coating on fuels.
5. Use of the concentrate eliminates costly mixing equipment and manpower requirements. The physical size of the air-tanker base facility is reduced by eliminating the need for large slurry mixing equipment and a warehouse for storing dry material, and by reduced storage-tank requirements.
6. Storage is not a problem in mild steel tanks. However, brass valves should not be used since any etching will cause the valve to leak. Region 8 has changed to stainless steel or cast iron valves on the retardant side of the system and has eliminated retardant leakage. A regular main-line watermeter has been used for 6 years with no apparent damage to the meter. By loading the 200 gallons of concentrate through the pump, and then following with 1,000 gallons of water, both pump and meter are thoroughly flushed after each loading. Consequently, a wide variety of centrifugal pumps (including aluminum impeller types) have been used successfully.
7. Overwinter storage of the concentrate has presented no problems since the salts in

the concentrate act as an antifreeze. Some slushing may occur at extremely low temperature, but not enough to damage the equipment.

8. One of our major concerns at the start of the program was corrosion of the aircraft. Much work was done on inhibitors by the Tennessee Valley Authority, the Fire Laboratories, and industry. But none would protect all the various alloys of aluminum and other metals used in aircraft. Despite this limitation, corrosion problems have been minor. We do not load the plane until we receive a fire call. The aircraft does not sit loaded. At the end of a day's operation, the planes are thoroughly washed down inside and out, with special attention being given to the wheels.

The fertilizer industry now has liquid concentrate facilities spotted throughout the United States, thus eliminating the need for the Forest Service to keep large quantities. The one basic drawback (visibility of the drop from the air) has not proven to be the problem first anticipated. While some method of coloring would still be desirable, the advantages and savings in handling and mixing far outweigh the visibility disadvantage. Region 8 has used liquid concentrate fertilizer as a fire retardant in a wide variety of fuels and of climatic conditions, ranging from semiarid in part of Arkansas to semitropical in part of Florida. This fertilizer has been very effective in all areas.

Buildup Index—*Continued from page 7*

computer facilities could be used to compute national BUI values and that an analysis could then be released on the National facsimile weather circuit. Because the BUI is a cumulative expression and requires some bookkeeping, the memory capabilities of the computer seem ideally suited to this task. However, some problems in implementing this idea would have to be resolved. Although approximately 450 to 500 weather reports are taken hourly throughout the country and transmitted on weather teletype circuitry, the basic observation time peculiar to the National Fire Danger Rating System is not uniform throughout the country. Also, the time available for transmission of the computed data or/and analysis may be difficult to obtain on the already crowded schedules of the facsimile circuits. If these problems are solved, a daily aid to fire control during the critical periods will be possible through BUI analyses.

To carry this idea one step further, once the problems mentioned above have been surmounted, it would be a simple operation to add forecast values to the computer input. At present, forecasts of all the weather elements affecting the BUI are already easily obtainable. The computer output would then include not only the current BUI but a series of forecast values corresponding to the time periods covered by the forecasts.

While these BUI analyses and forecasts may not be available in the near future, they are far closer than just a dream. The ESSA-Weather Bureau's high-speed communications systems and the capabilities of its computers are such that only technical problems need be solved to achieve reality.

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A BATTERY CARTRIDGE FOR FLASHLIGHTS

Wilford L. Keele
Salmon National Forest

Flishlight batteries have been prepared and wrapped in various ways for field use. They have always been inserted the same way—one by one. When four batteries are required, they must be placed carefully in series, two with the positive contacts up on the same side, and two with the contacts down. Often the batteries must be inserted in total darkness, and it is difficult to get them correctly installed. Time is also lost in the field while inexperienced men are assisted in properly inserting batteries.

Four batteries fastened firmly together in proper series by *pressure sensitive tape* form a *cartridge* that can be placed in the flashlight without a mistake (insert either way) making proper contact immediately (fig. 1).

To implement this idea using the present stock of flashlight batteries, a simple device or "jig" for holding them firmly can be used to make up the cartridges (fig. 2).

The General Services Administration can supply 2-inch pressure sensitive tape (#8135–663–3738) at $1.90 per 60-yard roll.

The jig must be so constructed as to assure firm contact of the terminals by means of pressure from one end as the batteries are placed in the device for taping. If metal is used for this pressure plate or holder, an insulating material, such as tape, must cover the metal to prevent battery discharge during the tape-wrapping process.

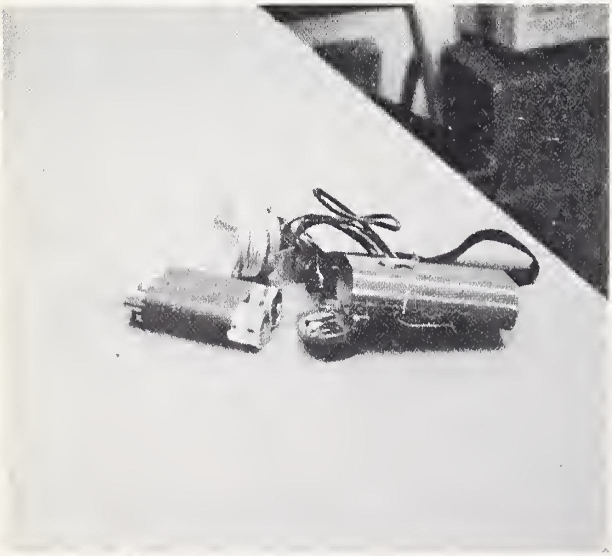

Figure 1.—Four-cell battery cartridge—no error in installation can be made.

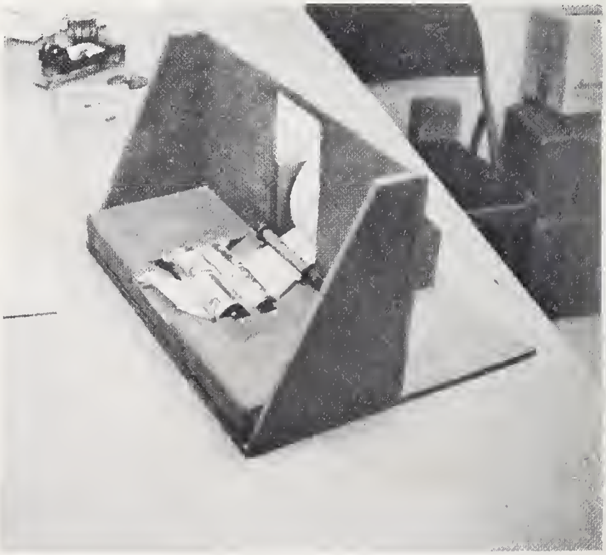

Figure 2.—Jig for quick battery cartridge construction.

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FIRE CONTROL NOTES

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FIRE CONTROL NOTES

A quarterly periodical devoted to forest fire control

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COVER—A fire starts on the rampage. Article on the next page discusses how atmospheric instability can play an important role in such a fire blowup.

(NOTE—The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such does not constitute an official endorsement or approval of any product or service by the U.S. Department of Agriculture to the exclusion of others which may be suitable.)

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Atmospheric Stability Forecast And Fire Control

ROLLO T. DAVIS[1]

Unstable air masses increase chances of big fires. Relative humidity seems to play a smaller role than thought before. Asmospheric stability forecasts, projecting stability for 36–48 hours, can warn fire control personnel when to expect erratic fire behavior and an increase in blow-up potential.

Have you ever wondered why some forest fires are extremely difficult to control while others, under seemingly like weather and fuel conditions, are relatively easy to curb? Even during dry periods when winds are high and humidities low, some fires show no erratic behavior or blow-up potential and are easily checked. But at other times, under apparently the same conditions, the wildest blow-up develops. Still more puzzling is the fact that some fires are almost impossible to control and become conflagrations even though the soil is wet, humidities are relatively high, and surface winds outside the fire zone are light. Why the difference?

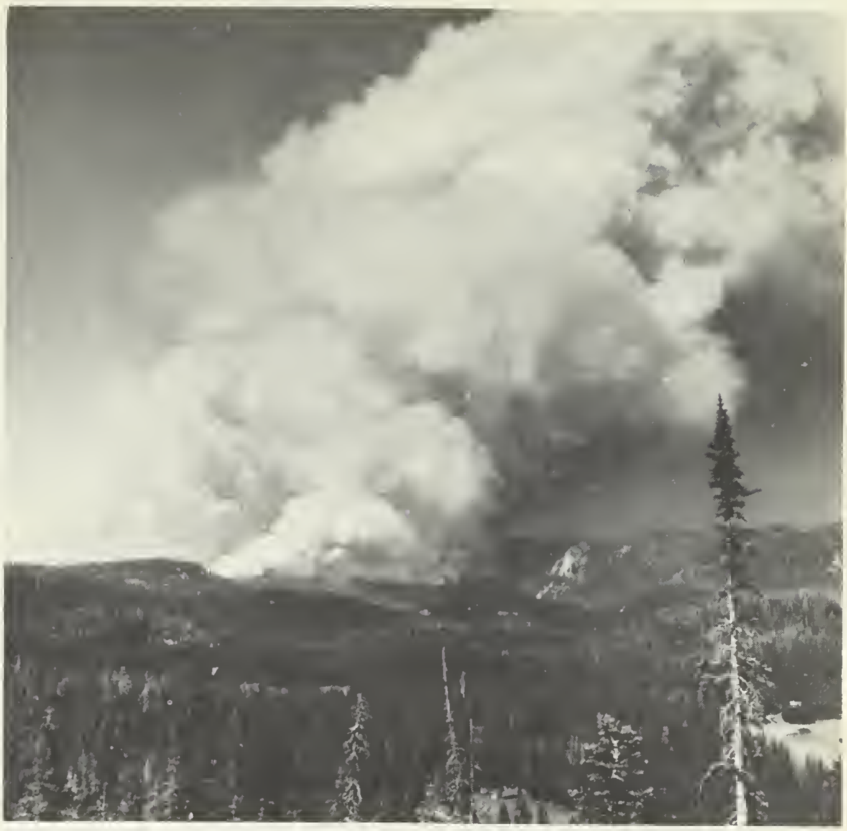

Figure 1—Convection currents visibly at work on a forest fire.

Blow-up characteristics of forest fires have been attributed to low relative humidities and strong surface winds. Papers have been presented about the relationship between relative humidities below 30 percent and large fires. Daniel J. Kreuger, former Georgia Fire Weather Supervisor, made a study of forest fires in Georgia for the years 1950-1959. He reported in the *Georgia Forest Research Paper* #3 that 77 percent of the fires burning 300 acres or more occurred when the relative humidity was 25 percent or less. Ninety-two percent of the large fires occurred when the relative humidity was 30 percent or less. Mr. Kreuger concluded:

1. Fires when promptly and adequately attacked (barring equipment failure), rarely, if ever, become large unless the relative humidity is 30 percent or less at the fire.

2. Potential for large fires increases rapidly as humidities fall below 25 percent. Fire fighters should increase their vigil whenever these low relative humidities exist or are forecast.

Atmospheric Turbulence

The relationship of atmospheric turbulence to erratic fire behavior has also been studied and discussed. As early as 1951, George M. Bryam and Ralph M. Nelson presented a paper titled "The Possible Relation of Air Turbulence to Erratic Fire Behavior in the Southeast."[2] In this paper, they pointed out the possibility of a direct relationship existing between unstable low-level air and extreme fire behavior in the Southeast.

(Continued next page)

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[1] Forestry Meterologist, ESSA Weather Bureau, Jackson, Miss.

[2] Fire Control Notes 12(3) 1-8; 1951.

Air Stability

Continued from page 3

A review of the weather conditions at the time of the larger fires occurring in Mississippi during 1967 revealed that large, hard-to-control fires did not necessarily occur on the days with the lowest relative humidities. In fact, the largest fires occurred 24 to 48 hours after a day with desert-like humidities. This pattern seemed to be begun by the passage of a cold front. With cold, dry, continental arctic air overspreading the State behind the front, the relative humidities often dropped below 20 percent. One to 3 days later, relative humidities started climbing, but fire severity and size also increased.

Hoping that this unexpected fire pattern might be explained, the daily surface weather maps and the temperatures from the surface to the 5,000 ft. level were critically examined for all days on which fires of more than 300 acres, classed as "E" fires, burned. The examination of the temperature profiles aloft strongly suggested that the atmospheric instability in the lower atmosphere played a significant role in erratic behavior of fires.

To investigate further, information on all 1967 fires of the class "E" and larger was requested from the Fire Control Directors of the States surrounding Mississippi. The requested information was supplied by Louisiana, Arkansas, Tennessee, and Alabama, and a total of 70 fires were investigated. No attempt was made to investigate weather conditions for fires when fire control personnel were unable to attack the fire shortly after it started.

Atmospheric stability in the layer between the surface and the 5,000 ft. level was categorized for the investigations as follows:

1. *Stable*—Temperatures aloft decreasing with increase in altitude at a rate about 3.5 degrees F or less per 1,000 ft.

2. *Conditionally Unstable*—Temperature decrease with increase in altitude at a rate of 3.5 to 5.4 degrees F. per 1,000 ft. (Conditionally unstable air tends to become unstable if forced to rise. Additional heat supplied at the surface is sufficient to produce the needed rise.)

3. *Unstable*—Temperature decrease with increase in altitude of 5.5 degrees F. per 1,000 ft.

4. *Absolutely unstable*—Temperature decrease with increase in altitude greater than 5.5 degrees F. per 1,000 ft.

Only six of the 70 fires studied occurred when the conditions in the low-levels of the atmosphere were classified as stable. Fifteen, or 21 percent, occurred when the air mass was classified as conditionally unstable, and fifteen others burned during unstable conditions. The greatest number, by a significant percentage, occurred when the air mass was classified as absolutely unstable. Thirty four of the big fires, nearly one-half of the 70 cases studied, burned when the air mass at the fire site was absolutely unstable.

Relative Humidities

Relative humidities in the area of the fires ranged from 18 percent to 80 percent. A large percent of the fires during periods when the atmosphere was absolutely unstable burned when relative humidities at the surface were above the level normally associated with big or erratic fires. Nearly 60 percent of the large fires studied took place when the relative humidity in the area was above 30 percent. Air mass stability, therefore, appears to be as significant, if not more significant, than low-level moisture in the behavior of forest fires once they got started.

It seems reasonable that air mass stability should play a very important role in the behavior of forest fires. Unstable air, from the meteorological viewpoint, is also convectively unstable. Once the air starts to rise, it will be warmer than its surroundings. The air continues to rise until it reaches a level where the temperature of the surrounding air is the same. When unstable air is displaced upward, it is replaced by air moving laterally, creating an indraft of air, which is also unstable. This air rises. With the heat of the fire being the initiating force to start and maintaining convection, a chain reaction is begun. The convective column increases in size, and the indrafts increase in velocity to fan the flames which then increase the heat to intensify convection, and so on (fig. 1). Fire control personnel are well aware of many of the direct and indirect effects of air mass instability on forest fires. Some of the more spectacular effects are rapid crowning, long distance spotting, erratic movement, and blow-up potential.

Conclusions and Recommendations

Most large fires occur when the temperature profiles through the lower levels of the atmosphere exhibit some degree of instability. Fire control foresters who are furnished daily with an atmospheric stability forecast can plan ahead

(Continued on page 15)

Chemical Thinning Reduces Fire Hazard

DAVID H. MORTON AND ELMER FINE [1]

Chemicals have been used successfully in precommercial thinning operations on the Colville National Forest. Not only does the method reduce thinning costs, it also prevents the creation of a fire-hazardous situation and subsequent fire protection problems. (fig. 1).

Since 1962, the Colville National Forest in northeastern Washington has carried on an extensive thinning program in young, coniferous pole stands on about 12,800 acres of overstock old burns. Both machine- and hand-thinning methods have been employed—the latter method being used in stands with up to about 2,000 stems per acre. In stands denser than this, where trees are usually smaller, mechanical thinning with dozers and choppers is more suitable and economical.

The fire hazard which may be created by precommercial thinning is a serious problem. For example, the chainsaw method commonly employed in hand-thinning operations often results in heavy slash that remains a threat to the residual stand for a number of years (fig. 2).

Chemical Thinning

To overcome this problem, chemicals were used for hand thinning and have been found to be a tool that will satisfactorily meet not only silvicultural and economical objectives, but also those of fire control by keeping fire hazard conditions static.

The chemical thinning process uses a hypo-hatchet injector and Silvisar 510 tree killer. An automatic injection system within the hatchet releases the silvicide into chops made in the bole of the tree. The success of this method in eliminating excess trees and saving time and money has been phenominal. Ninety-five percent of all treated trees are effectively removed as a competing factor in the stand, and total costs of the operation average $21 per acre compared to nearly twice that much for the chainsaw method.

Reaction to Chemicals

The reaction of treated trees to Silvisar 510 is an interesting study in itself. If treated anytime within the growing season, the kill is quite rapid. In warm weather, dying needles can be detected within three days after application, and within two weeks, the entire foliage of a 50-foot tree may be brown. A high percentage of the kill is in this shorter period of time; further studies have shown that kill of seemingly resistant branches may continue into the next growing season. Treatment of conifers in the dormant seasons does not show until spring or when the vibrant growing processes of the tree begins. Douglas-fir treated in January remains green until the growing season begins, then browns at about the same rate as one treated in April. Western larch, when treated with bare limbs, gains almost full needle growth before the needles react to the silvicide, brown, die, and fall.

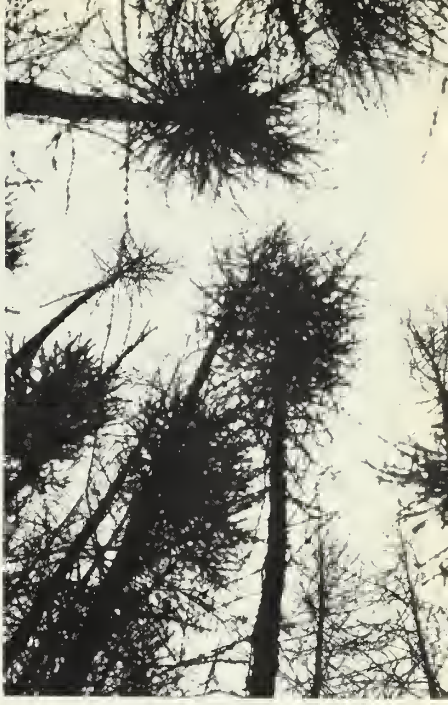

Figure 1—Crown release effect in chemically treated stand. Full, green crowns reduce fire hazard.

Needle fall and deterioration of twigs, limbs, and finally the bole itself, of treated trees are the critical factors in the buildup of a slash hazard in this thinning operation. In chainsaw thining, nothing is left in the upper limits of the crowns to provide a fuel, but the mass accumulation of slash on the ground is extremely hazardous. The added drying from sun and wind keeps these ground fuels in a combustible condition for several years until crowns close over, vegetation regrows, and slash deteriorates.

Hazards Eliminated

Chemical thinning eliminates the slash and drying hazards.

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[1] Respectively, Forester and Forest Dispatcher, Colville National Forest.

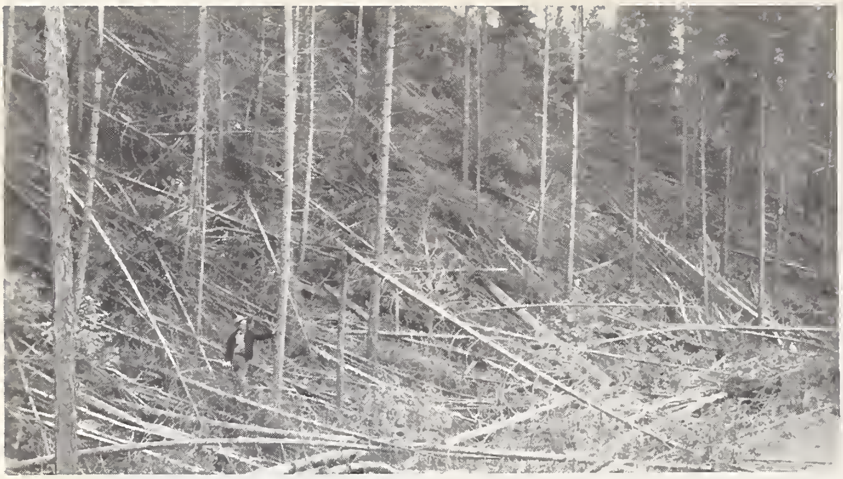

Figure 2—Three-year-old chain-saw thinned area showing considerable fire hazard still remaining from the slash.

Chemical Thinning

Continued from page 5

An accumulation of slash does not build up anywhere in the stand (fig. 3). Immediately after thinning, needles brown and die on all species treated. Some species, western larch, hemlock, and Englemann spruce, shed needles within three weeks after browning. Douglas-fir retains needles slightly longer but not beyond one growing season. Western red cedar, grand fir, and lodgepole pine retain a significant amount of needles through the first year after treatment, but after two winters, few needles remain. At no time do these dry needles seem to represent significant fire hazard. Fine twigs and branches, pencil size, two years after treatment, have shown very little evidence of deterioration. In some instances, rotting of the boles of the treated trees, especially near the ground line, has begun. It appears, however, that the stem of the tree will remain standing for quite some time. The deterioration rate is so slow that there is no significant slash buildup.

Other Advantages

There are several other advantages to chemical thinning. The killed trees protect the crop trees from sun scald and weather damage. The skeletons of killed trees significantly reduce sun and wind as drying agents. Light meter readings taken in chemically thinned stands show a 30 percent decrease in exposure compared to the stands where excess trees are felled. Although the chemical thinning does increase drying slightly more than in the wild stands, it is far below those conditions created by the chainsaw method.

Standing dead stems, resulting from trees killed in the chemical thinning process, do not represent a significant fire hazard after needle fall. The dead trees in the thinning operations are below or within the canopy of live, green trees. Very few trees are killed whose tops protrude to a position where sparks could be carried for any distance, and, anyway, the adjacent, green tops would deflect and catch sparks before much distance could be covered. Spotting, associated with snags or dead trees in wildfire, would not occur to any significant degree.

The likelihood of fire reaching the tops of the dead trees is low. In thinned stands, natural pruning removes most fine fuels from the lower quarter of the boles of the trees. Without an accumulation of material under the trees to heat up, a wildfire, in most cases, would not be any different than in unthinned stands.

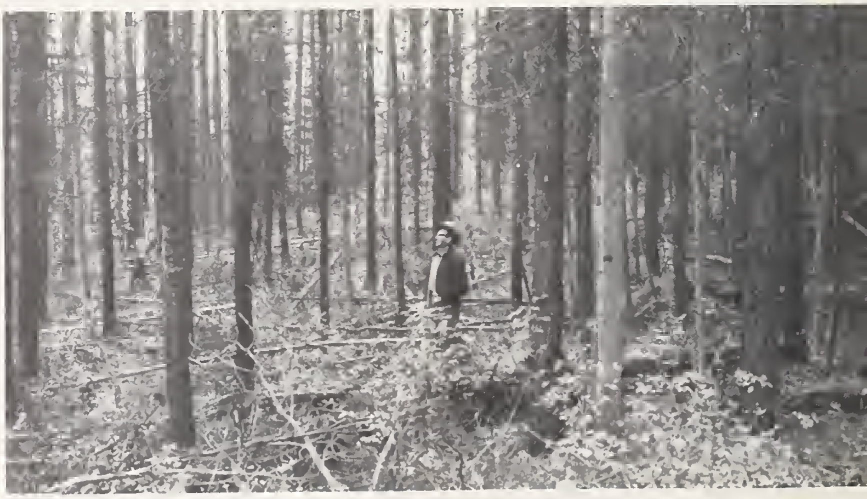

Figure 3—The entire stand pictured has been thinned. The left side was treated by felling excess trees; the right side was treated with chemicals.

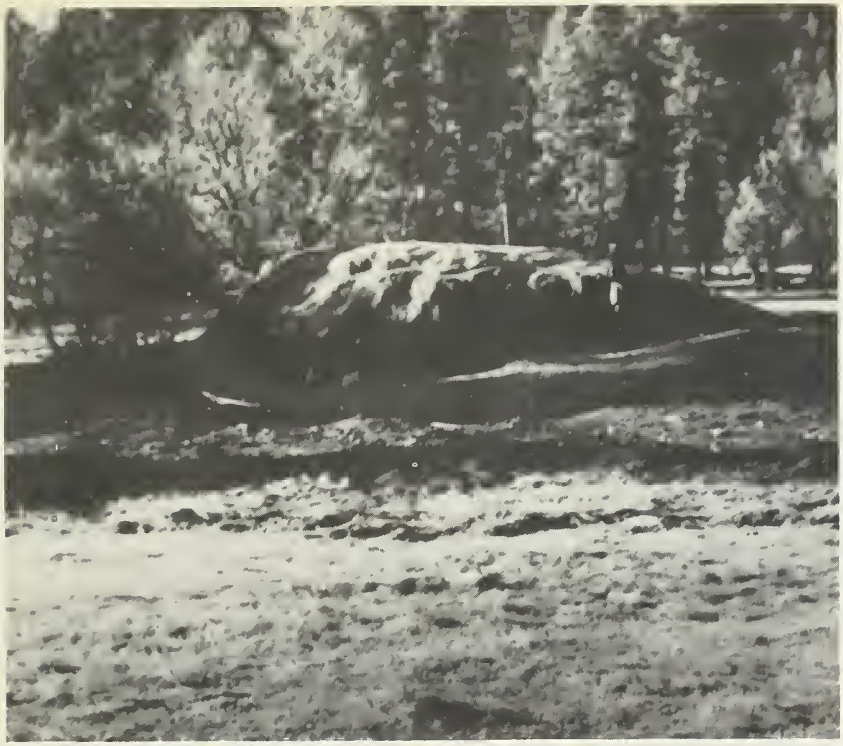

Figure 1—View of sawdust pile after fire was finally extinguished.

Back to Nature

Returning the chemical thinned area to a natural condition, as far as fire control is concerned, is not an important issue. In chainsaw thinned areas, it is very important that the canopy close to increase shade and wind deflection and for slash accumulations to deteriorate. However, in the chemical thinned stands, these factors are insignificant. As standing, dead trees slowly deteriorate and fall, the crowns of leaves will also be increasing. An abrupt change will not occur because the natural spread and growth of live crowns cover the space left by dead trees. Normal spacing objective in thinning operations has been 13 by 13 feet. Crown diameters have generally averaged 6 feet, leaving a space of nearly 7 feet to be filled by growing crowns. Crop tree crowns will probably begin touching within 15 years. At the same time, deterioration and falling of the killed trees should be nearly complete.

An added advantage of chemical thining over chainsaw methods is the lesser impact on the aesthetics of the treated area. Without the accumulation of material on the ground, it is less likely to be apparent to a casual observer that anything has been done to the stand.

Fire Prevention

Although there has not been a wildfire in any of the thinned areas, it is clearly evident that extra suppression effort will be required should one occur in the ax, chainsaw, or dozer-thinned stands. Accordingly, special fire planning and fire control measures have been

(Continued on page 15)

A New Way To Snuff Out Burning Sawdust

HARRY NICKLESS[1]

During the late elk season of 1965, a hunter put out a cigarette in an old sawdust pile. The pile was 10-20 ft. high and covered an area 75 by 100 ft. Surrounding this area was an area of decomposed sawdust 150 by 200 ft. (fig. 1). The pile came to life and burned from time to time during the fall. Winter snows soon followed, and the sawdust pile was covered with 4 to 6 ft. of snow.

Under Snow—Fire!

In March 1966, as the Fire Danger was approaching Moderate, the sawdust pile started burning again. The burning parts of the sawdust were worked over with a fireplow and later with a D-6 Cat. The old sawdust, which was wet, was turned over and mixed with the burning material in an attempt to put out the fire.

During April, the Fire Danger was Moderate. The sawdust pile continued to show signs of fire every time there was a slight breeze. A portable pump was placed in a nearby creek, and two men spent 2 days flooding the burning sawdust pile and working out the burning pockets by hand. But since smoke continued to show,

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[1] Fire Control Assistant, Apache National Forest.

People Programs For Fire Prevention

RUDY ANDERSON [1]

Fire prevention programs which stress the involvement of people have proven to be a worthwhile approach in the Black Hills National Forest.

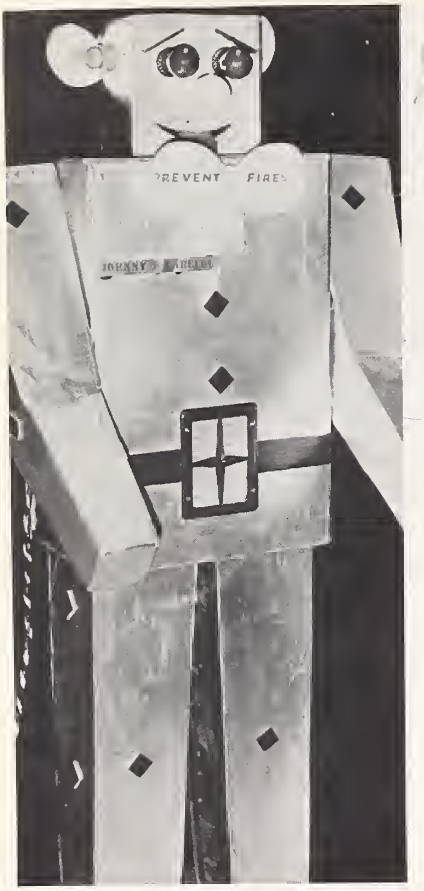

Figure 1—Johnny B. Careful helps to dramatize fire prevention presentations.

The Black Hills Forest has a high potential for man-caused fire, since most all areas are accessible by road. Private land within the forest compounds the problem with industries, ranches, year-long residences and summer homes scattered throughout. Recreation and tourism raise chances of man-caused fires. Over two million people traveled the highways and backroads during the summer of 1968. More are expected each year.

To counteract increasing fire hazards, a fire prevention technician for the forest was appointed in 1963. The position was to strengthen the fire prevention program by exploring new aproaches and methods of personal contact.

School Programs

School children have been most important to the prevention program. All schools in the Black Hills area, grades one through six, are contacted yearly, and two age-graded programs are given.

Programs receiving the most favorable response had student participation. A fire story was told with cardboard cutouts applied by the students to a large, magnetic board which depicted a green forest, showing a slow change in the scene as a wildfire advanced. A fire demonstration dramatically showed the children the hazards of pressurized containers, gasoline fumes, electrical wiring, and hot grease.

After three years of varied approaches, a written program evaluation test was given to the students and teachers. They retained a surprisingly large percentage of information. In addition, each student was requested to take the test home and go over it with his parents. A sample count of 445 students showed 84 percent of the students took the test home.

For the school program in 1968, a life-size robot, named Johnny B. Careful, was constructed from cardboard boxes and equipped with flashing lights and a sound system (fig. 1).

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[1] Fire Prevention Technician, Black Hills National Forest.

Snuff Sawdust

Continued from page 7

one or two men had to be sent daily to the sawdust pile on patrol and mopup.

By May, the Fire Danger was High and approaching Extreme. From time to time, small crews from the Job Corps Camp were dispatched to the burning sawdust pile to put out the burning pockets. Two-man District crews made regular patrol and mopup of the sawdust pile. Among other methods, they put all burning embers in a garbage can and filled the can with water. Still the sawdust pile continued to burn.

The Answer

Finally, a successful tactic was tried. Four 57-lb. bags of dry Phos-chek were mixed into the hotspots. The Phos-chek was raked into the top 4-6 inches of sawdust. After this treatment, no further burning was noted. No doubt any of the long-term retardants would probably have done the job. This method may also be useful in controlling ground fires. △

Johnny B. Careful required two men, one man behind the scene to operate the lights and robot voice and the other man to conduct the program with the student body. The script consisted of questions answered by the ranger, the robot and the student body.

A factor to consider in school programing is involvement of other cooperative fire agencies. These agencies are usually willing to participate in school programs, and students are impressed to see several agencies work together.

Displays

Education by displays is another important area of people participation and involvement. Two mobile display units, a rear view slide projection system (fig. 2) and a miniature sawmill (fig. 3) have helped take the fire prevention message to the people.

The sawmill is a working model. Small logs are sawed into boards and the boards stamped: "Prevent Forest Fires—Black Hills National Forest." These are distributed to the audience. The unit always draws a large audience wherever it is on display. The value of this display unit is its hand outs.

The mobile slide projection system is versatile. It is completely self-sustaining with a viewer-operated push button to start the slides and sound systems. Two display panels on each side of the viewing screen are removable. By inserting a different slide tray and tape cartridge and by changing the four display panels, the theme can be changed quickly from fire to timber to recreation to whatever is wanted. The various display panels are stored in the rear of the unit.

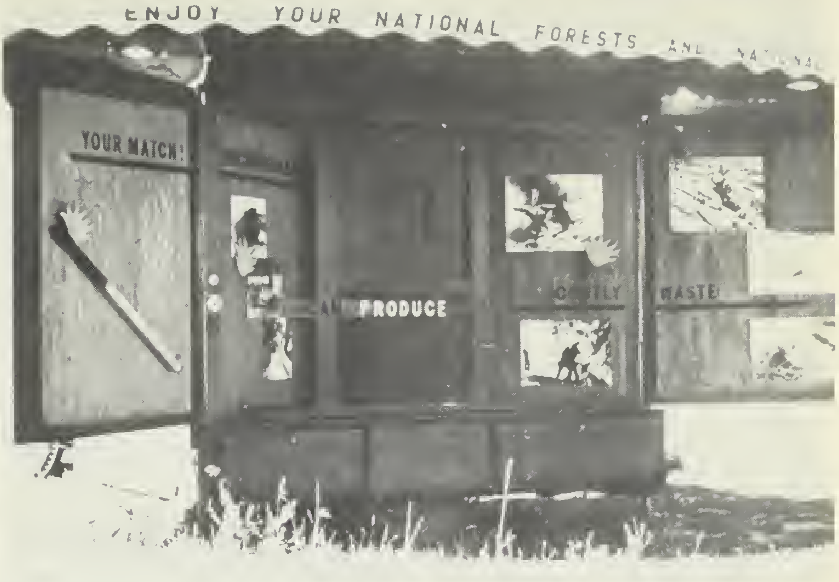

Figure 2—This unit is quickly set up, and the display material can be easily varied.

News Media

A prevention program is no better than its news media support. Again, involvement is the key to success. When a fire becomes Class C or larger, the area news media are immediately informed. A public information officer is assigned to the fire area, and he works directly with the news media people, giving fire information and directions for taking photos. If reporters are not on the scene, the public information officer supplies them with information by phone. The newspapers will give space to forest fires when they are given the facts about them.

Personal contact with the news editor has proved to be the most successful contact when specific prevention programs need promotion. The news editor gets information orally or in written outline form, and he presents it to the public. Many times this personal contact has made the difference between an item getting good coverage or not.

The daily fire index reading is currently one of the major programs in the Black Hills Forest area. The leading newspaper in the area publishes daily the fire index on the front page during the fire season. The same index is presented with the local weather report on the major television station in the area. When very high and extreme fire conditions exist, specific emphasis is placed on the index.

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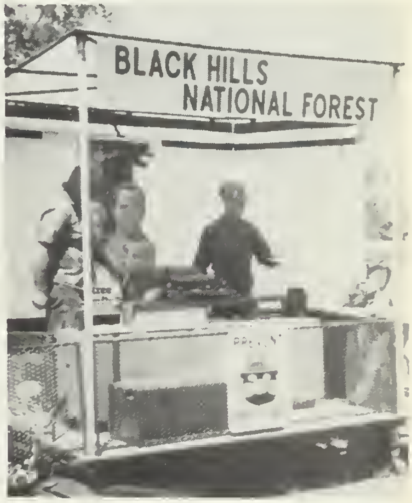

Figure 3—A working model of a sawmill always draws large crowds.

Fire Follow-up Critiques Fight Future Fires

~~1st Lt.~~ John H. Maupin [1]

Fire follow-up critiques have proven to be beneficial to the fire control effort at Hunter Liggett Military Reservation.

Hunter Liggett consists of 176,000 acres of rugged, grass and brush covered terrain in central California, bounded on the north and west by the Los Padres National Forest. Due to artillery firing and associated military training, fire incidence is high.

After each fire, a fire follow-up critique is held. Short meetings are also held for drills and rolls on suspected smokes. To keep details fresh, discussions are held as soon as practical after the fire is put out.

Who Attends

The fire boss is at all meetings and acts as moderator, leading firefighters and other fire department personnel in a recount of the operation. The dispatcher also attends, since he often has an excellent overall picture of the fire.

If only a few people were involved in the fire, each one is called upon to give his interpretation of what happened. After larger fires, when many more people are involved, the fire boss calls on a cross-section of firefighters. The fire boss is careful to call on new men since many misconceptions are discovered by hearing their viewpoints. Also, the inexperienced men may bring up important items that the experienced men have forgotten or taken for granted.

The Critique

The fire boss opens each session with a brief outline of fire weather and fuel conditions that existed at the time of the fire. Recounts are sequential, and they cover events from the time the fire call was received until the crew returned to the station. Sometimes a blackboard and colored chalk or an overhead projector are helpful in diagramming the life of the fire.

Small fire follow-ups are specific, and such details as response time, hose lays, snag felling, cause and prevention of the spread of the fire, tools used, and line construction are discussed. Large fires demand a much more general discussion, covering topics such as fire weather, line location, and utilization of support facilities or reinforcements. Also, safety hazards and the employment of special procedures, such as backfiring, and equipment, such as bulldozers or air drops, are discussed.

After everyone has given his version of the fire, the fire boss clarifies issues in question and brings up any pertinent topics that he thinks have been omitted.

(Continued on page 14)

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[1] Post Fire Marshall, Hunter Liggett Military Reservation.

Marsh Funnel Table Revised

Charles W. George and Charles E. Hardy [1]

Revised table gives flow rates for all currently used fire retardants.

About 3 years ago, the Marsh Funnel was modified so that the viscosity of all forest fire retardants then used could be determined in the field. The data were obtained by comparing viscosity from the Brookfield Viscometer with the flow-through time for the Marsh Funnel; thus "Marsh Funnel time" serves as an inexpensive criterion of actual viscosity.[2] [3]

Revised Table

The revised table includes only products currently used. Newest of these is Phos-Chek 202 X/A (see page 16).

The Marsh Funnel Packet is still available. It contains the table, the instructions for converting a Marsh Funnel, and a list of commercial sources. Separate tables and the Packet can be ordered from Northern Forest Fire Laboratory, U.S. Forest Service, Drawer 7, Missoula, Montana 59801.

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[1] Intermountain Forest and Range Experiment Station, Northern Forest Fire Laboratory.

[2] George, Charles W., and Charles E. Hardy. Fire retardant viscosity measured by modified Marsh Funnel. U.S. Forest Serv. Res. Note INT-41, 4 pp., illus. 1966.

[3] George, Charles W., and Charles E. Hardy. Fire retardant viscosity measured by modified Marsh Funnel. Fire Control Notes 28(4): 13-14, illus. 1967.

Root Feeder Suppresses Fires

Richard J. Barney [1]

A root feeding needle, fitted to a fire hose, deeply saturates heavy accumulations of fuel and partially decomposed organic matter better than conventional nozzles, stream or fog type. Also, less water is used by the needle.

Heavy accumulations of fuels and partially decomposed organic matter, such as peat, mosses, and humus, are abundant throughout the interior of Alaska. Road construction and land clearing activities often create large concentrations of mixed fuel and organic soil. During periods of high fire danger, characterized by high buildup indexes, these fuels can burn to considerable depth. Extinguishing fires during these periods is often difficult and usually requires large volumes of water. Normal application procedures do not always get water down into the fuel where it is needed. Rather than soak, conventional nozzles, both stream and fog type, have a tendency to throw firebrands and to waste water because of runoff. A nozzle which places water in the center of these organic fuels could reduce the total amount of water necessary and improve the efficiency of the suppression technique.

The Feeding Needle

The idea of using a tree surgeon's feeding needle seemed worth trying. The feeding needle (fig. 1) is normally constructed with ¾-inch spray hose fittings; it was modified to use a 1½-inch national fire hose female thread adaptor. The needle is equipped with a shutoff valve and is approximately 40 inches in length. The pointed tip has side holes which direct water in four directions (fig. 1).

In use, the needle is easily inserted into the fuel to the desired depth. Sometimes, slightly opening the valve assists the insertion process. Once the needle is inserted, the valve can be fully opened. The period of time the needle is left in each location depends on the specific fuel. The needle is then moved from place to place until the control or mopup job is completed.

Field Evaluation

The needle was given to the Fairbanks District, Bureau of Land Management, Division of Fire Control for two fire seasons. General reaction to the needle performance was enthusiastic. Various personnel and crews reported that the needle was a real help in controlling and mopping up the deep burning fires.

Flow Rates

A flow-rate check was made because crews involved in field testing thought the needle put out more underground fire with less water than their standard adjustable nozzles. This field observation seemed reasonable

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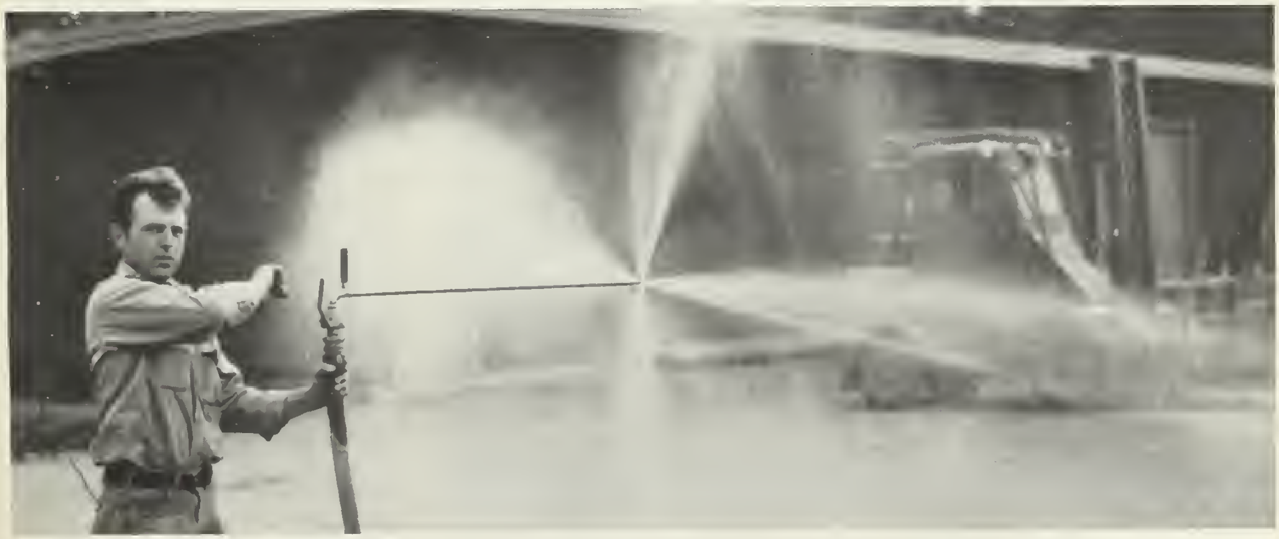

Figure 1.—Feeding needle and spray pattern.

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[1] Fire Control Scientist Pacific Northwest Forest and Range Experiment Station; headquarters for the Station is at Portland, Oregon. The author is located at the Institute of Northern Forestry, College, Alaska.

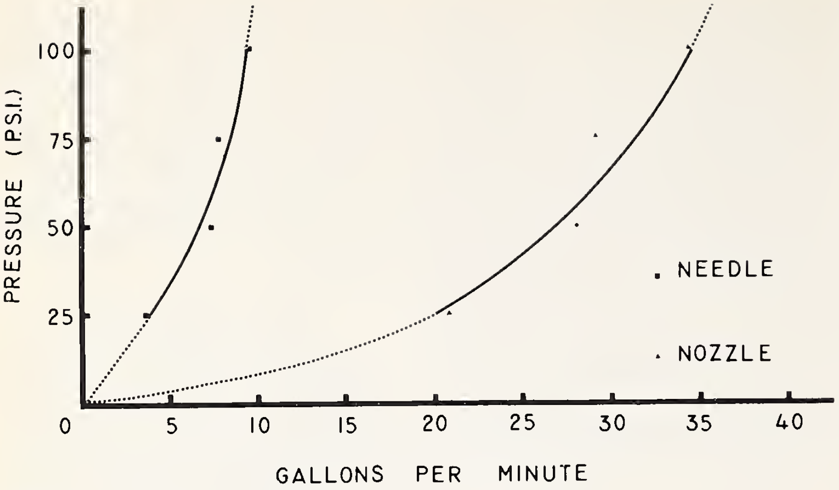

Figure 2.—Needle and nozzle flow rates at various pressures.

Root Feeder

Continued from page 11

since the needle openings were smaller than those of the nozzle. However, an experiment was run to determine how much difference actually existed between units in waterflow per unit of time. This information would also give a tanker operator some idea of how long his supply of water might last using either type of nozzle for control or mopup.

In the flow-rate check, a Western Fire Equipment Co. Nozzle, No. 4A711, set approximately midway between full spray and full stream pattern, was used for comparison since it is more or less a standard nozzle for tankers and portable pumps in interior Alaska. The selected nozzle setting represented a pattern which is used in much of the local suppression work. The Bureau of Land Management's 1,200-gallon tanker truck, equipped with a front-mounted Barton-American centrifugal fire pump, type UA50, was used as the water source. A 32-gallon garbage can was calibrated and used to catch the water. Runs were timed and flow rates calculated for four pressure levels determined by the pump gauge. Pump pressures of 25, 50, 70, and 100 pounds per square inch were selected because they cover the range most used by various crews on both tankers and portable pump units. The 1½-inch hose was selected since it is the standard size hose of the Bureau of Land Management in Alaska.

Figure 2 illustrates the results of the flow test. Obviously, the feeding needle uses considerably less water per minute. At the 25 p.s.i. level, the ratio is about 5 to 1; whereas at 100 p.s.i, the ratio is approximately 4 to 1 with the standard nozzle flow rate compared with the needle flow rate.

Other Tests

In addition to the flow-rate check, some subjective tests were made by actually wetting typical fuels. These tests substantiated the usefulness of getting water into the center of fuels with the needle. In several cases, with the conventional nozzle and essentially similar amounts of water, the wetting went down only a few inches before additional water ran off. The needle, however, completely saturated the vicinity where it was placed, making the area muddy. One explanation for these apparent differences is that the organic fuels used in the tests have a very high surface-to-volume ratio and act as a sponge. Therefore, a considerable amount of water is necessary to saturate the area near the surface before additional amounts will penetrate downward. The needle provides a means to get water at the desired level without having to saturate the levels above.

Discussion and Summary

It appears that the needle can be an effective tool in combating fires in deep, organic fuels. This tool not only uses considerably less water per unit of time but also places it at the depth desired. Modifications could possibly improve the performance; however, the needle seems to perform in a satisfactory manner as originally designed.

Although the manufacture recommends operating the needle at 250–350 p.s.i. using ¾-inch or ½-inch pressure hose for tree feeding, we obtained good performance at lower pressures using 1½-inch hose. Higher pressures seemed to increase water blowback from underground along the needle shaft thus reducing the effectiveness of getting water into the fuels at depth. As in all nozzle work, caution should be taken by operators to avoid stream explosions caused by hitting hot pockets underground. Drawing the needle out of the ground slowly improves the saturation throughout the fuel complex encountered. With a little practice, the operator can use the needle quite effectively. △

Airtanker Tested For Drop Pattern

Brian S. Hodgson [1]

Water-drop tests of the new Canadair CL–215 airtanker indicate it has an effective pattern length of some 240 feet when a 0.5 second delay sequence drop is made.

The CL-215 Airtanker

The Canadair CL–215 airtanker has recently completed its water-drop performance trials. The CL–215 is an amphibious, twin-engine, water-bomber aircraft. It can pick up 12,000 pounds of water in 15 seconds, scoop-filling at 70 miles per hour from lakes as small as one mile long. The water bombing system has two tanks, each with a capacity of 6,000 pounds and each consisting of a removable portion above the floor and a lower fixed portion integral with the hull structure. The two drop doors, 63″ long and 32″ wide, form part of the bottom of each tank. The pilot or co-pilot can trigger the water drop by pressing a button on his control wheel; he can empty the tanks together, individually, or in sequence.

Test Measurement

The technique for standardized, impartial measurement used for the CL–215 is the one developed for water-bombing aircraft throughout Canada by the Flight Research Section of the National Research Council of Canada in conjunction with the Forest Fire Research Institute in Ottawa. The test program has served as a background for future work to be done on tree canopy interception and also to test a mathematical model developed for the prediction of the ground distribution of water released from an airtanker.

One part of the test program called for calibrating drops of water to determine the ground distribution pattern. The results for the CL–215 in this phase of testing are the bases of this article.

In anticipation of a larger pattern than with other aircraft tested, the ground distribution grid plot was extended to an area of about 680 by 200 feet for the CL–215. The 15 by 7.5 foot grid spacing of the cup holders was retained except for the last two rows where it was increased to 15 by 15 feet. The collecting unit was a 10-ounce paper cup with provision for a tightly fitted lid, the cup being held in a crimped metal can nailed to an 18-inch wooden stake and wire-locked securely.

For each test run, a total of 1,163 cup-can units were used, each stake identified by a letter and number corresponding to its position in the grid. Prior to placing in a holder, the cup was numbered with the corresponding coordinate value. After each test drop, any cups containing water were capped, collected, and weighed.

(Continued next page)

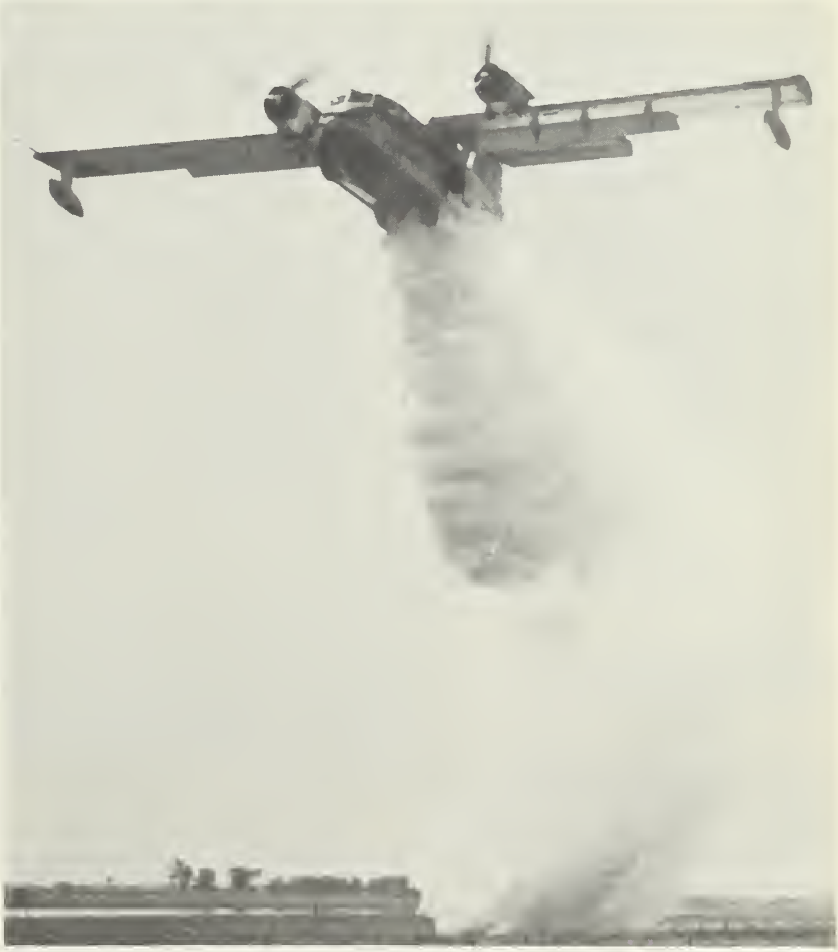

Figure 1—A view of the CL-215 dropping water, with 1 second delay between door openings. Canadair photo.

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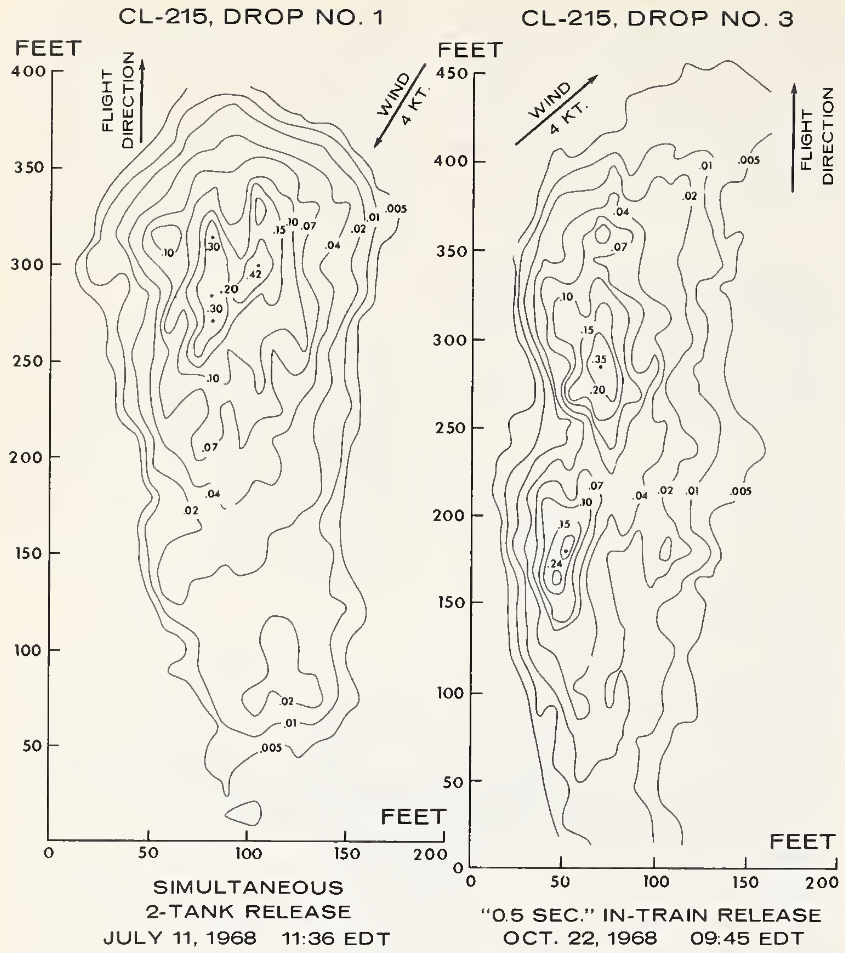
[1] Fire Research Officer, Department of Fisheries and Forestry, Canada.

Fire Follow-up

Continued from page 10

Results

As a result of fire follow-ups, fire response time has been shortened, and new refinements in firefighting techniques have been developed. Fire safety is strengthened, and fire control efficiency has increased. Fire follow-ups effectively reinforce the methods of fire control to new men and serve as refresher for the old hands. These sessions also provide an opportunity for new men to take advantage of the knowledge of the more experienced men. Not least of all, effective fire follow-ups yield benefits in acreage saved and accidents prevented. △



SIMULTANEOUS
2-TANK RELEASE
JULY 11, 1968 11:36 EDT

"0.5 SEC." IN-TRAIN RELEASE
OCT. 22, 1968 09:45 EDT

TEMPERATURE	72°
REL. HUMIDITY	61%
ALTITUDE	118'
AIRSPEED	104 KT.
GROUND SPEED	100 KT.
RECOVERY	80%
ON SITE WIND	4 KT.
GALLONS DROPPED	1200 IMP. GAL.

TEMPERATURE	46°
REL. HUMIDITY	85%
ALTITUDE	97'
AIRSPEED	94 KT.
GROUND SPEED	97 KT.
RECOVERY	74%
ON SITE WIND	4 KT.
GALLONS DROPPED	600+600 IMP. GAL.

Figure 2—Contour patterns for salvo and sequence drops. Graphs from Flight Research Section, National Research Council of Canada.

Airtanker

Continued from page 13

Evaluation of Tests

The Flight Research Section wrote a computer program to analyze these results to give the coordinates necessary to plot the distribution contour lines in inches of water rather than gallons per 100 square feet. (0.01"=0.52 Imperial gallons of 0.62 U.S. gal./100 sq. ft.)

Drop pattern variations were made with ½- and 1-second interval delays between door openings, producing a longer water pattern than if the two doors had opened simultaneously (fig. 1).

The contour diagrams shown are those for a simultaneous salvo drop and a sequence drop with a 0.5 second delay between door openings. (fig. 2)

If we consider the 0.07 inch contour (4.4 U.S. gal./100 sq. ft.) as that required to retard a fire, then for the salvo drop the effective pattern length is about 165 feet and for the sequence drop with 0.5 second delay is 240 feet. The PBY Canso, another airtanker tested, had an effective pattern length of 150 feet with an 80 pound load.[2]

Results

The preliminary tests indicate some work will have to be done on the drop system to reduce the peak contours that occur in the distribution pattern. The water contained in these peaks is wasted because it represents water quantities higher than those required for fire suppression. Effects on the pattern of a change in the opening rate of the drop doors, the extent to which the doors open, or the interval between the opening of successive doors, needs more investigation. △

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[2] Hodgson, B.S. A procedure to evaluate ground distribution patterns for water dropping aircraft. Inform. Rep. Forest Fire Res. Inst., Ottawa, No. FF-X-9, 1967.

Marsh Funnel

Continued from page 10

Instructions for Using the Marsh Funnel

1. Place the appropriate tip in the Marsh Funnel.

2. Cover the hole with a finger and pour a freshly agitated sample into the clean, dry upright funnel until the fluid level *exactly* reaches the bottom of the screen.

3. Measure the time in minutes and seconds for *1 quart* of retardant to flow through the funnel (the funnel hold approximately 2 quarts).

4. Look up measured time on lefthand side of table. Read proper column to the right to find viscosity in centipoise.

NOTE—A. The viscosity reading depends on time because agitation and temperature of retardant will vary. The viscosity found in the table will be for the retardant at the existing settling time and temperature.

B. For the samples tested, the Marsh Funnel method gave viscosities within 5 percent of the Brookfield method.

C. Numbers included within the boxes indicate the normal usage range. △

Air Stability

Continued from page 4

and use their manpower and equipment better.

Upper air temperature data are readily available at all ESSA Weather Bureau Offices where Forestry Meteorologists are stationed. These data enable the forestry meteorologist to determine the degree of atmospheric instability. Using other meteorological information available, such as the computerized lifted index prognostic charts, the Forestry Meterologist can project the stability into the future and come up with a forecast of the atmospheric stability for the following 36 to 48 hours. Considering the value of such forecasts to the forestry industry, the atmospheric stability forecast should be a routine product of all weather offices, and fire control personnel should be trained to use it. △

People Programs

Continued from page 9

Smokey Bear

Smokey Bear now has his day in South Dakota. Each spring, the Governor of the State proclaims a Smokey Bear Day to emphasize the approaching fire season and call attention to Cooperative Forest Fire Prevention. On this day, a mass distribution of CFFP material is made throughout the State by Federal, State, and cooperating fire agencies.

The program has been very successful—and with added benefits. First, the material *is* being distributed, and all key areas *are* covered. Second, in coordinating areas of distribution, other agencies and organizations not previously interested in fire prevention participate. The most valued benefit is news coverage. Spot announcements are periodically aired over the radio three days prior to the CFFP distribution. Television covers Smokey Bear Day, and news articles appear in all weekly and daily papers just before the distribution.

Fire Prevention Week

In the fall of 1968, an air show was organized strictly for fire prevention publicity. All cooperating agencies, the State Forestry Department, National Park Service, State Park Department, the Rural Electrification Agency, volunteer fire departments, and law enforcement agencies, in coordination with the Forest Service, put on a demonstration of fire equipment and related activities. The show was a success because people not familiar with firefighting saw the massive organization needed for a major fire. An aerial tanker retardant drop was demonstrated. The helicopter and helitack operation was explained and demonstrated. Pumps, tools, safety equipment, fire trucks, and communication equipment were all on display and were all demonstrated. A fire story was told, and as it was told, people saw how many tax dollars were spent because of other people's carelessness.

Summary

New approaches in fire prevention are necessary but are not the total answer. Involvement of people is necessary but again is probably not the total answer. The Fire Prevention Program in the Black Hills seems to be successful because new approaches in fire prevention and people involvement have been combined. People are the problem and it takes people to solve it. △

Chemical Thinning

Continued from page 7

required for these areas. In contrast, no similar special precautions have been necessary for the chemically thinned stands.

As a result of these studies, even though their duration has been short, an acceptable method of hand thinning has been established. Chemical hand thinning follows good sivicultural practices and certainly does not increase the fire hazard in thinned areas. △

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See article, page 10.

MARSH FUNNEL TIME—FIRE RETARDANT VISCOSITY RELATIONS[1]

Time for 1 quart to flow through a funnel[2]		Fire retardant material						
		Gelgard M		Phos-chek			Fire-Trol 100	
				202	202 X/A	259		
		Large tip[3]	Small tip[3]	Large tip	Large tip	Small tip	Large tip	Small tip
Min.	Sec.	Centipoise						
0	15						930	
0	20				557		1530	
0	25				767		Air 1900	
0	30				966	5	2140	
0	35				1155	20	2330	
0	40			540	1334	43	2480	920
0	45			680	1502	66	2590	1110
0	50			800	1659	Ground 89	2680	1250
0	55	520		900	Air 1806	112	2750	1370
1	00	550		1000	1942	136	2800	1460
1	05	580		1080	2067	159	2840	1540
1	10	610	210	1150	2183	182	2880	1610
1	15	640	230	1210	2287	205	2900	1670
1	20	Ground 660	250	Air 1265	2381	228	2920	1720
1	25	680	265	1320	2465	251	2930	1770
1	30	700	280	1380	2538	274	2940	Air 1810
1	35	720	300	1420		297	2950	1840
1	40	740	315	1470		320	2960	1870
1	45	760	330	1520		343		1900
1	50	780	342	1560		367		1920
1	55	800	355	1600		390		1940
2	00	820	370	1640		413		1960
2	15	865	410	1755				
2	30	908	442	1855				
2	45	945	477	1935				
3	00	980	Ground 508	2010				
3	15	Air 1014	537					
3	30	1045	564					
3	45	1072	591					
4	00	1098	616					
4	15	1123						
4	30	1147						
4	45	1171						
5	00	1188						

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[1] Viscosities by Brookfield Model LVF, at 60 r. p.m., spindle 4 (except spindle 2 for Phos-Chek 259)

[2] Funnel must be FULL to screen before testing begins.

[3] Large tip diameter should be 0.269 ±.002 inch; small tip inside diameter should be 0.187 ±.002.

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FIRE CONTROL NOTES

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FIRE CONTROL NOTES

A quarterly periodical devoted to forest fire control

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Fire Simulation Livens Lookout Training

James A. Burnaugh and
Ira T. Kittell

Provided a simulated smoke sighting and the proper equipment with which to report it, the fire lookout trainee gains valuable "actual situation" experience.

The first use of fire simulation was the "Command Simulator," used to train fire bosses and their supporting staffs. The program was so successful it sparked interest to train others in different fire disciplines.

The Shasta-Trinity National Forest staff considered the possibility of developing exercises in initial attack, fire size-up, or decision making for crew foremen and fire detectors. Fire detection was selected because of the need for a new approach in training detection personnel.

In February 1968, a program called "Advanced Training for Detection Personnel" was prepared utilizing a simulator exercise. The format developed for the detection exercise follows the standards prepared for the Fire Simulator Instructor Training, Marana, Arizona, November 1967.

Smoke Sighted!

The projected scene is a 35 mm. slide view typical of the trainee's area. Smoke manipulation in simulation is critical: The smoke must conform to the fire behavior conditions of the script. The trainee should be unable to see the smoke at first but should gradually see an increase in volume and density.

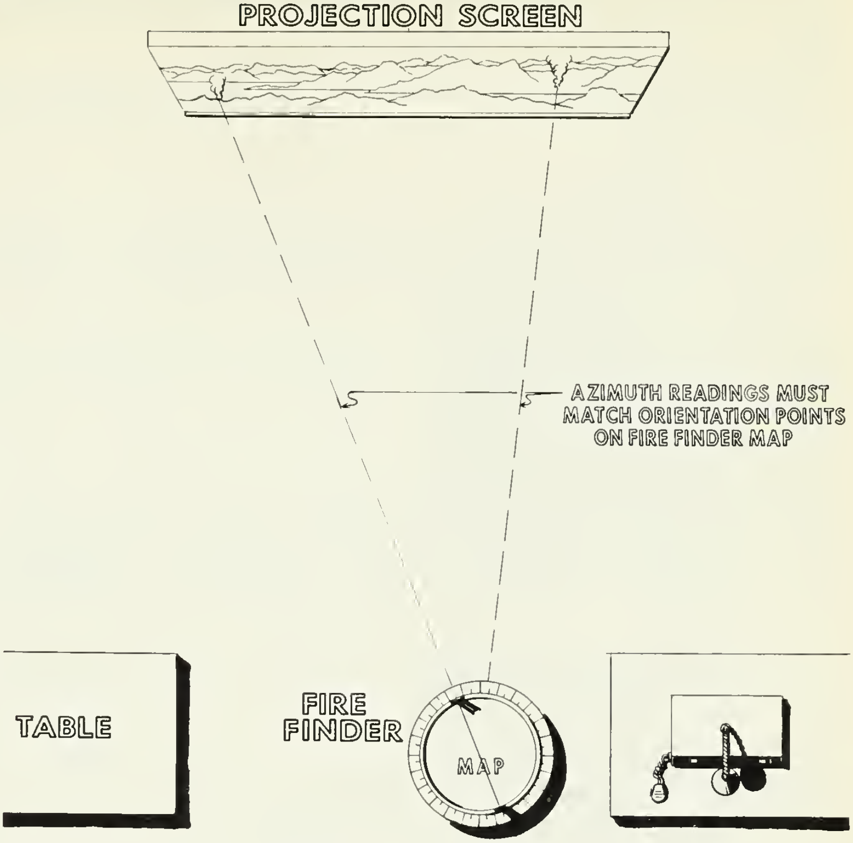
PROJECTION SCREEN
AZIMUTH READINGS MUST MATCH ORIENTATION POINTS ON FIRE FINDER MAP
TABLE
FIRE FINDER
MAP

Figure 1—Arrangement of equipment for smoke sighting exercise.

The trainee, upon discovering the smoke, should "report" the fire to the central dispatcher (Cover). His report is expected to follow the prescribed manner: An azimuth reading of the smoke; its distance, size, and character; legal description; and geographic location. Followup reports are prompted by the central dispatcher.

Emerging situations present opportunities for the lookout to relay messages of importance in a concise, orderly manner and use proper radio code. The exercise has one principal trainee and as many trainee observers as room allows. Trainee observers are encouraged to follow the actions and keep notes. A District Fire Control Officer is assigned to criticize the exercise and evaluate the trainee's performance.

Positioning Important

It is most important to position the "fire finder" so that azimuth readings will correspond exactly with the picture on the screen and the map on the "fire finder." Figure 1 illustrates the arrangement of the equipment necessary to the exercise. Procedure in orienting the alidade to the screen image: From fire finder map, select an orientation point that is recognizable on the screen and identifiable on the map.

→

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[1] Dispatchers in the Shasta-Trinity National Forest, Region 5.

Aluminum Rake Handles Better

William Roberts[1]

Aluminum broom rakes have long posed a problem to firefighters. Not only do the undersized handles cause blisters because they have to be held tightly, but the metal itself tends to stain the hands black. Firefighters on the Mark Twain National Forest have found that a section of automobile heater hose can solve both of these problems.

A 3/4-inch section of the hose is ideal for the square-handled rakes and a 1-inch section will slide snugly over the round handles (Fig. 2). Increasing the diameter of the handle with a pliable material and covering the metal eliminates both blisters and blackened hands.

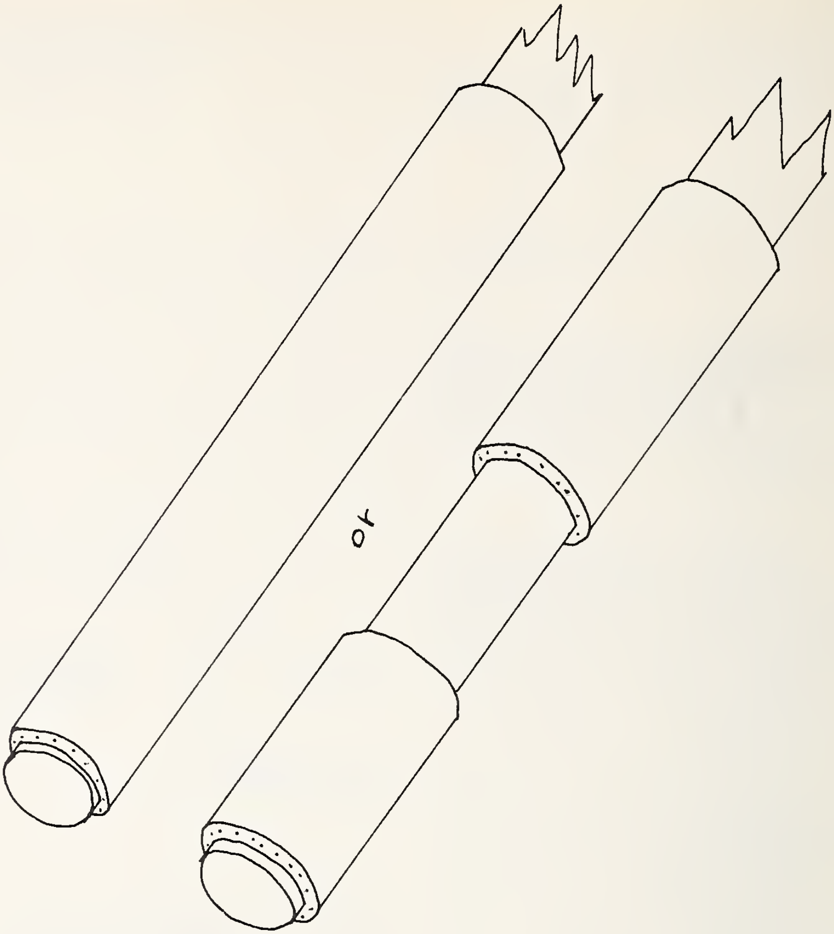

Figure 1—Ways of attaching the hose.

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[1] Forestry Aid, Doniphan Ranger District, Mark Twain National Forest, Region 9.

→

Compute the azimuth from the map. Holding alidade sight set on the computed azimuth, move alidade until orientation point lines up in the sights. The reference line is now established along which the alidade must remain.

To complete the orientation, select another orientation point recognizable on the map and the screen. Again measure the azimuth; now set the sights on the new azimuth. Move the alidade along the reference line until the second orientation point lines up in the sights. When both orientation points line up in the sights on the proper azimuths, the alidade is properly oriented in the exact relationship the lookout tower would be to its seen area. Therefore, any other point in the projected image will agree with the fire finder map.

Color slides taken from other than established lookout locations can be used provided the point where the picture was taken can be accurately plotted on a map and orientation procedures described above are followed.

Simulation Educates

There are two types of communication training practiced during this session: (1) The procedural type, when the lookout relays coded or non-coded messages, (2) the interpretive type, when the lookout accurately interprets what he sees.

The lookout simulation exercise provides the trainee an opportunity to actually practice the standard procedure of reporting a fire. It gives the trainee a chance to develop good habits or to correct bad habits.

Knowledge and experience are gained by trainees and instructors alike while working under the stress created by this simulator exercise.

Drying Rates of Some Fine Forest Fuels

C. E. VAN WAGNER [1]

In a series of laboratory tests, removing waxes and resins from the cuticles of pine needles and aspen leaves greatly increased their drying rates.

It seems reasonable to expect that the thinner a bit of dead vegetation is the faster it will dry. The experiments described in this article were prompted by the doubt that this assumption is true of all important fine fuels in eastern Canada.

Set-up

The dead, natural materials tested were pine needles, aspen leaves, pine twigs several inches long, grass, and reindeer moss. Also included were two forms of prepared white pine wood that have been used as standard fine fuels in Canadian forest fire research, namely, match splints (2 1/2 in. long by 1/8 in. diameter) and slats (10 x 1/4 x 3/32 in.). First, parts of some samples were boiled in xylene to remove wax and resin; then they were warmed gently to expel all xylene. Next, all materials were soaked in distilled water for three days, and several grams of each were allowed to dry, individual pieces well separated. The drying materials were weighed at intervals for 8 to 10 hours and again the next morning. The room during the tests was 78 ± 2° F. and 35 ± 5 percent relative humidity; air movement was negligible. Finally, the samples were oven-dried for 24 hours at 100° C., and the percent moisture content was calculated for each weighing.

Analysis Procedure

To analyze each drying run, the final or equilibrium moisture content (E) was subtracted from each successive moisture content (M) and the resultant free moisture content (M-E) was plotted against time (t) in hours on semilog paper. This treatment produced a descending straight line for material that dried

Rates, page 7.

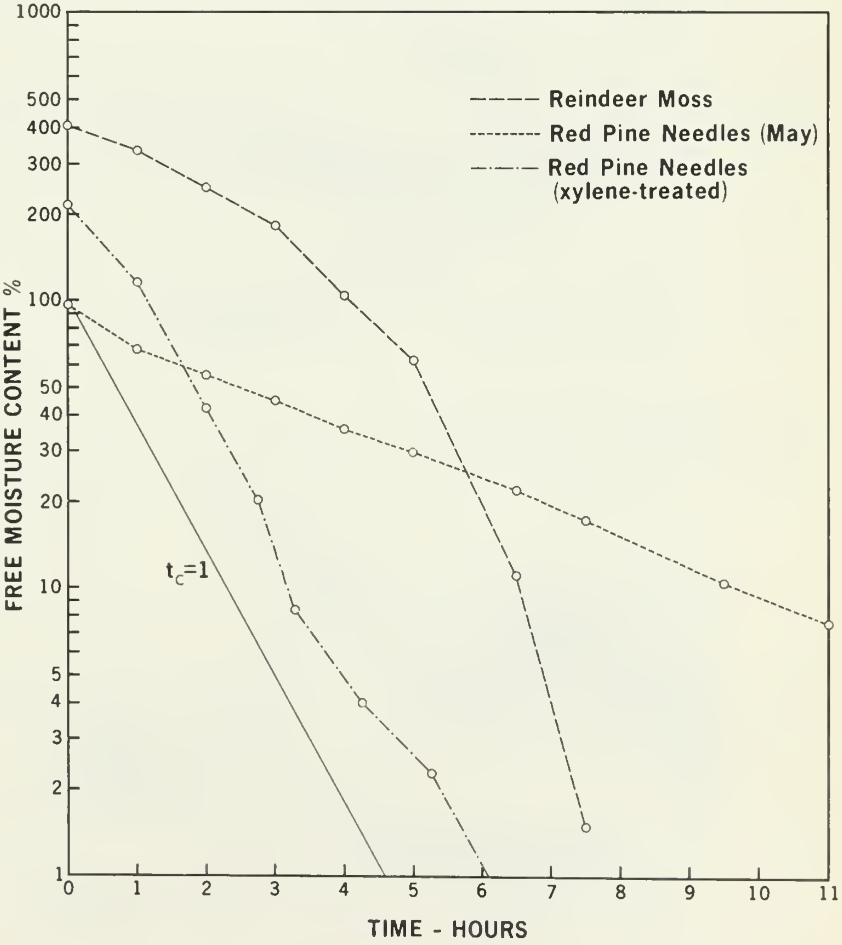

Figure 1.—Drying runs for reindeer moss and for red pine needles with and without xylene treatment. Slope of 1-hour time constant shown for comparison.

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[1] Forest Fire Research, Department of Fisheries and Forestry of Canada, Petawawa Forest Experiment Station, Chalk River, Ontario.

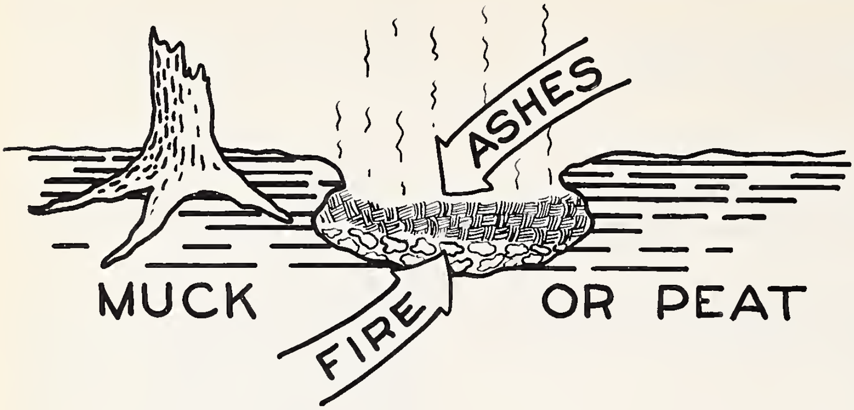

Figure 1—Cross section view of typical muck or peat fire.

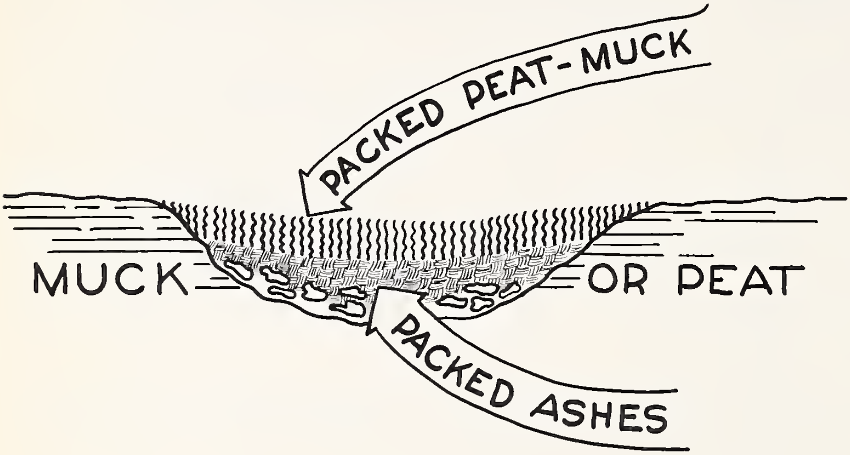

Figure 2—Cross section view of a fire suppressed with a bulldozer.

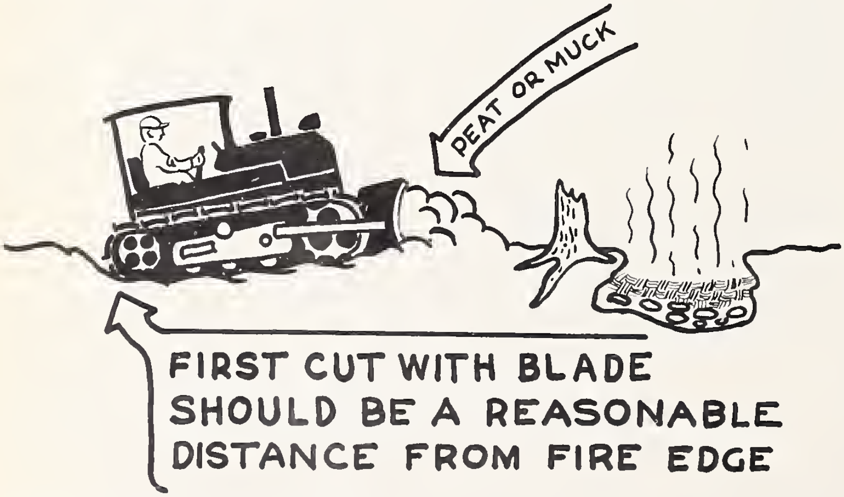
PEAT OR MUCK
FIRST CUT WITH BLADE SHOULD BE A REASONABLE DISTANCE FROM FIRE EDGE

Figure 3—Start of the attack on a muck fire.

New Answer To Suppressing Muck Or Peat Fires

Lyman Beach[1]

Muck fires can be controlled by smothering them with bulldozed muck. Water trapped underneath the cover also helps suppress the fire.

Have you ever shoveled too much coal onto a fire and nearly caused it to go out? Remember when the oven became too hot in the old coal or wood burning stoves, and Grandmother shoveled on ashes to cool the fire?

Same Techniques Used

This is the basis for the techniques developed to suppress muck and peat fires without pumping water. Tests indicate that muck or peat will sustain combustion even when it contains 70 percent moisture by weight.

This is a lot of water that can be put to work. The new answer to muck fire suppression is simply to bulldoze unburned muck over the ashes and compact them in place. The layer of ashes acts as insulation between the fire and the muck spread over the top. The insulating layer of ashes must remain as undisturbed as possible. The muck over the ashes acts as a lid. This lid traps many of the gases vaporized by the burning muck. Condensation forms under the bulldozed lid of unburned muck, and the fire dies. The muck or peat bulldozed over the fire also drastically reduces available oxygen.

---

[1] Forest Fire Officer, Forest Fire Division, Michigan Department of Natural Resources.

Figure 1 illustrates a typical muck or peat fire.

Bulldozer Action

Figure 2 illustrates a cross section view of what the fire should look like after suppressing it with a bulldozer. A dozer with a blade that can be angled works best. This enables the operator to drift the unburned peat or muck over the perimeter of the fire in long passes. A straight blade makes the operator spend too much time in back and forth motions.

The dozer operator must be cautious when working at the edge of a muck fire. If he should break through one of the tunnels of fire usually around the fire's edge, he is in danger of mixing more fuel directly with the fire. When hot spots develop, they usually occur along the former fire perimeter. For this reason, the perimeter of the fire requires a generous supply of well compacted peat.

Figure 3 illustrates the beginning attack on a muck fire. Note the first cut with the blade should be a reasonable distance from the fire's edge.

Figure 4 illustrates that the supply of peat or muck should be taken behind the first cut with the dozer blade.

Covered Fires Die

Covering muck fires is much faster and more efficient than using water. It requires less manpower, and all the equipment and work involved in pumping is eliminated.

The only requirement in using a bulldozer is that the peat or muck must be able to support a working dozer. △

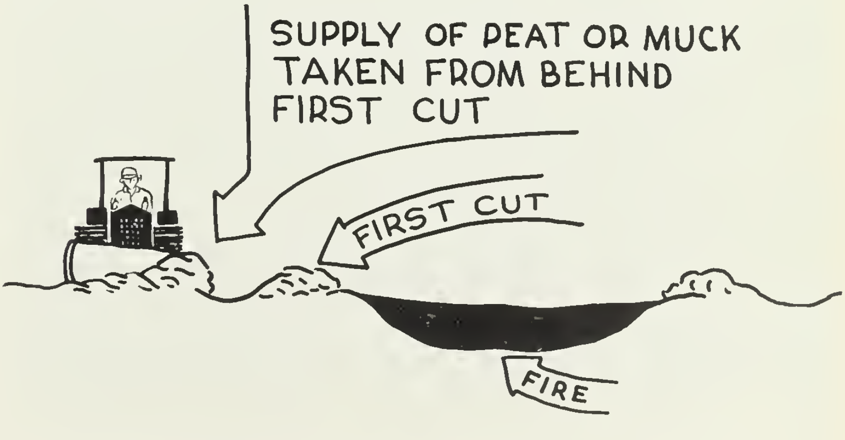

Figure 4—Supply of peat or muck is taken behind first cut.

Rates, from page 5.

exponentially, i.e., whose instantaneous drying rate was proportional to the instantaneous free moisture content. The slope of the semilog graph, called the log drying rate, was a measure of the speed of the drying process. Many of the test runs followed this pattern closely enough for practical purposes; two that did and one that did not are illustrated in figure 1. When straight, these graphs have empirical equations of the form:

$$\log \frac{M_0 - E}{M - E} = Kt \quad (1)$$

Where M_0 is moisture content at time zero, M is moisture content after t hours, and K is the log drying rate in log M per hour.

The exponential drying process can also be described by the time constant (t_c), which is the time required to accomplish 1 — 1/e, or 63 percent of the expected change in M. The log drying rate K (in logarithm to base 10) is related to the time constant by the expression

$$K = \log_{10} e / t_c = 0.43/t_c \quad (2)$$

The two measures of drying speed are thus interchangeable and are worked out for each tested material in table 1. Included in figure 1 is a line showing the slope of a drying process with a 1-hour time constant. Some materials, e.g., reindeer moss in figure 1, do not have a true log drying rate or time constant except as an average over the whole run.

Wax Slows Drying

The relatively slow drying rates of pine needles and the marked effect of the xylene treatment suggest that, for some leaf materials, diffusion through the waxy cuticle is the limiting step in the drying process. Once this diffusion step exerts its influence, the

Rates, page 12.

Railroad Spark Arresters Tested

DONALD G. DOWDELL [1]

Although there is no written standard for spark arresters for large engines, the State of Washington has recently approved two spark arresters tested and developed by the Great Northern Railway. Use of these arresters will reduce fires caused by carbon particles.

During the last 2 years, there have been many advances in the development of spark arresters for locomotives. Several public agencies, railroads, and spark-arrester companies have acted aggressively in developing efficient arresters.

The Washington State Department of Natural Resources has participated in many meetings and tests and has been the catalyst for the development of efficient spark arresters for locomotives.

No Written Standard

There is no written standard for spark arresters to be used on large engines. The Society of Automotive Engineers is currently working on a standard, but it has not yet been accepted. Washington State has developed its "abbreviated standard" for testing locomotive spark arresters. This standard closely resembles USDA Forest Service Standard 5100–1, which is used for testing spark arresters for medium-sized engines.

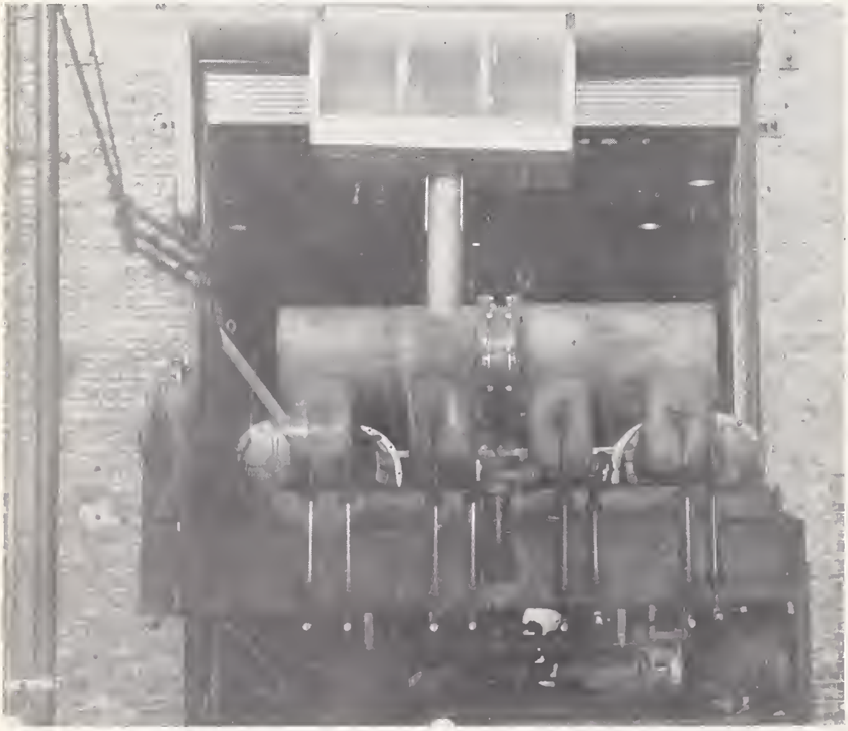

Figure 1—Test manifold mounted on the air tank with carbon feeding mechanism in foreground. Each clear plastic tube contains 100 grams of carbon. Scavenging blowers are in background. The large enclosure trap on the exhaust stack traps particles more than 0.023 in. in diameter.

The Washington Standard

The Washington "standard" requires the arrester to be at least 80 percent efficient in retention or destruction of all carbon particles 0.023 in. in diameter and larger, for 25-100 percent of the locomotive's engines exhaust flow rate. With the arrester added, the total back pressure on the engine cannot exceed 3 in. of mercury.

Meetings with railroads and the protection agencies have been taking place since the early 1950's, with little improvement of spark arresters for locomotives.

Breakthrough in Arresters

The first breakthrough in efficiency was achieved in 1967 when an arrester was developed that had great potential in carbon retention, but its back pressure was too high. Through further testing and development, the back-pressure problem was solved with no reduction in efficiency.

Another major spark-arrester development occurred in January 1968. A modification for a cyclonic spark arrester was developed, increasing its efficiency to more than 80 percent. Also in 1968, the Great Northern Railway Company led in developing test procedures and in conducting tests for locomotive arresters. This company has conducted bench tests and locomotive tests on many spark arresters. Great Northern tests were conducted in April, July, and August, 1968. This series of tests showed that many of the previously accepted arresters were less than 50 percent efficient. The Great Northern tests showed three arresters to be more than 80 percent efficient for carbon 0.023 in. in diameter and larger throughout the flow rate range of engine idling to maximum r.p.m. The three arresters also maintained the back pressure at less than 3 in. of mercury at full throttle on a GP–9 locomotive.

---

[1] Prevention & Training Officer, Fire Control Division, Department of Natural Resources, State of Washington.

Two Large Locomotives

Great Northern used GP–7 and GP–9 naturally aspirated locomotives in their tests. They also developed a bench operation capable of producing the airflow of a locomotive. The bench test used two scavenging blowers (Root's locomotive blowers) driven by electric motors to produce the large volume of air needed for the tests (fig. 1).

Procedures

The procedure developed for the locomotive spark arrester testing is quite simple, but it does produce results that can be measured and evaluated to determine arrester efficiency. Night observation tests were tried but were quickly proven unreliable.

The reliable tests consisted of injecting a known amount and size of carbon into the eight legs of the manifold while the locomotive was running. About 15 minutes was required to feed 100 grams of carbon into each leg. Above the arrester a large, 28-mesh wire-screen enclosure trap was placed to catch everything greater than 0.023 in. coming through the arrester. The amount of carbon that escaped through the arrester was compared to the amount injected into the arrester to determine its efficiency. Tests were run at various throttle settings on both the bench and on locomotive engines (figs. 2 and 3).

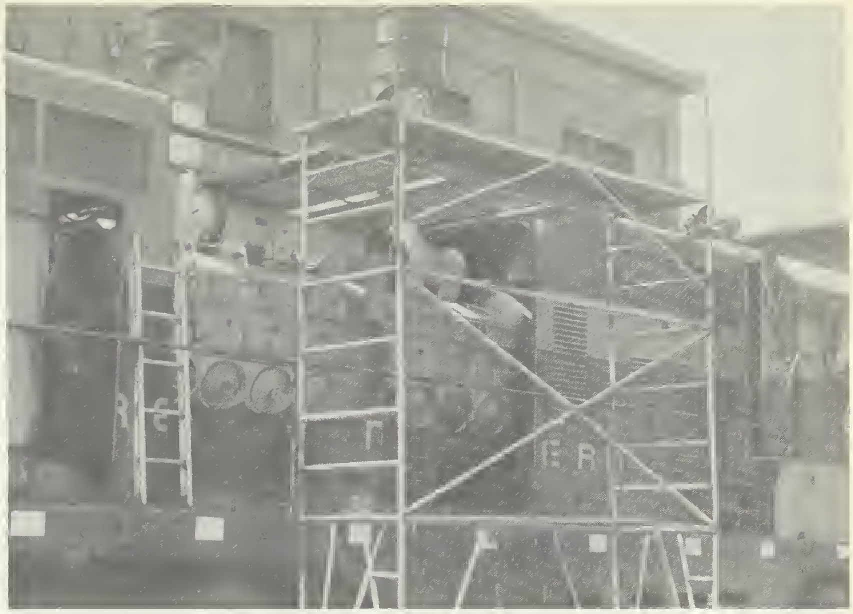

Figure 2—Test manifold mounted on a GP-9 locomotive. The spark arrester developed by the Great Northern is mounted on the manifold exhaust stack. The spark arrester is topped with a modified 55-gallon barrel that has a screen at the top to trap particles more than 0.023 in. in diameter so arrester efficiency can be determined.

Two Approved

The Washington Department of Natural Resources has approved two spark arresters for use in Washington. By using either of these arresters, the railroads will greatly reduce or eliminate fires caused by expelled carbon particles. △

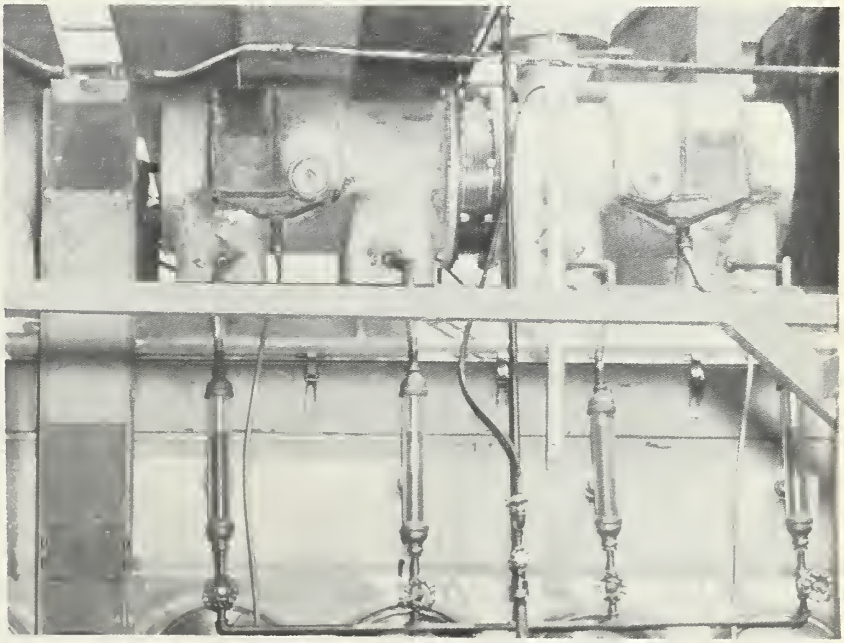

Figure 3—Close-up of manifold mounted on locomotive showing carbon feeding mechanism. Manifold shows a modification of the Farr Company "packet".

Do Smog Reducers Increase Fire Hazards?

ROB HARRISON [1]

Because exhaust pollution devices might increase exhaust pipe surface temperatures, thereby increasing fire hazards, investigative tests have been run. Based on the exhaust system's "first bend" temperature, the Equipment Development Center at San Dimas found the smog reducers do not greatly raise exhaust pipe temperatures. However, other factors were found to increase fire hazards.

Fire Control officials have expressed concern over the possible increase of vehicle exhaust pollution (smog) devices on all new sedans and pickups. Any temperature increase could lead to serious fire hazards. The Equipment Development Center at San Dimas has conducted tests to measure surface temperatures of pickup and sedan exhaust systems to determine if such a hazard exists.

Tests on Vehicles

Tests were conducted with Forest Service pickups and sedans, approximately half of which were equipped with smog control devices. The exhaust system of each of the vehicles was instrumented to find its surface temperature. Each vehicle was subjected to a series of test runs on a road course and on a chassis dynamometer. The dynamometer tests indicated the maximum temperature that could be reached by the vehicle, while the road test served to indicate the temperature that would be reached under normal operating conditions.

The Road Course

The road course used consisted of 7 miles of an average grade of 3 percent used for the warmup section and approximately one-half mile of about 7 1/2 percent grade used for the test section. When a 40 mile per hour vehicle speed was used, this 7 1/2 percent grade section was long enough to ensure reaching the maximum equilibrium exhaust system temperature.

Dynamometer

For dynamometer testing, the engine was run at the same speed as for road tests and was loaded to its maximum horsepower. In addition to "heating tests," the exhaust pipe cooldown times were noted, both with engine idling and with engine shut off.

"First Bends" As Indicators

It was found that the most critical area was the "first bend," that bend closest to the exhaust manifold likely to come in contact with ground cover. Table 1 shows the results of tests on 20 Forest Service vehicles of three different makes. Vehicles were equipped with comparable engines and transmissions. The table shows in every category that for only one manufacturer are smog device equipped vehicles likely to develop significantly higher temperatures than those not equipped. However, all the temperatures shown under "Road Test" are well above the combustion temperature (re-

TABLE 1.—*Average first bend temperatures*

	Manufacturer 1	Manufacturer 2	Manufacturer 3
ROAD TESTS			
Equipped	954°F	873°F	1080°F
Unequipped	947°F	855°F	849°F
DYNAMOMETER TESTS			
Equipped	1080°F	1050°F	1210°F
Unequipped	1070°F	1062°F	1002°F

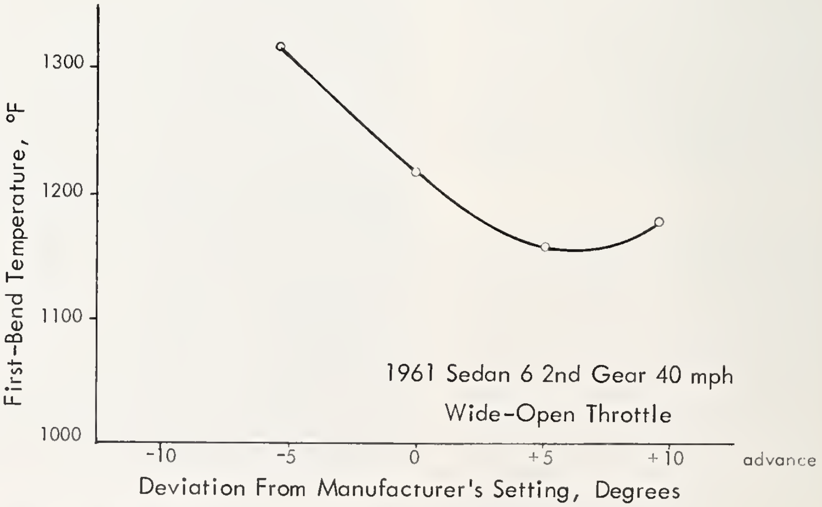

Figure 1—First Bend Temperature as a Function of Ignition Timing.

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[1] Mechanical Engineer, Equipment Development Center at San Dimas.

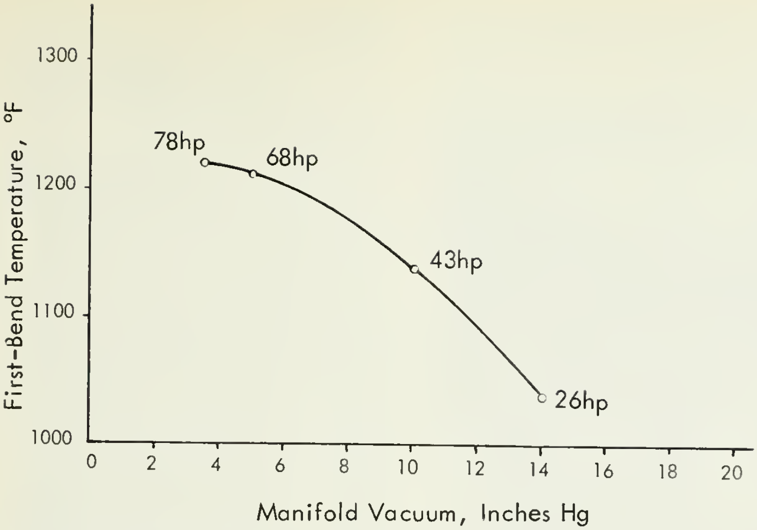

Figure 2—First Bend Temperature as a Function of Engine Load.

ported variously as 750°F and 660°F) for dry grass or pine needles.

Phase Two Tests

The second test phase determined the effect of varying engine adjustments on exhaust system temperatures. This was done by changing such variables as back pressure, ignition timing, etc., on one vehicle and testing to determine the effect of these changes. This provided valuable information about the relationship between engine "tuneup" settings and exhaust pipe temperatures. Figure 1 shows the "first bend" temperature as a function of ignition timing. Note that retarding the timing significantly increases the temperature. It was noted that a 1-psi increase in exhaust back pressure raised the exhaust pipe temperature only 5°F. Changing fuel-air ratio did not cause significant differences.

Results

As expected, engine speed and load had a marked effect on the system temperature. Figure 2 shows the variation in temperature as a function of load (manifold vacuum) and Figure 3 shows temperature variation as a function of the engine speed at three different constant loads.

Another interesting fact developed is that the highest exhaust pipe temperatures are found in situations similar to the road test, involving long, straight, fast, steep pulls. Table 2 shows temperatures encountered on five different types of roads. Note that the temperatures occurring on Forest Service land utilization roads are the lowest seen, because of the slow speed and light load dictated by the nature of the road surface, grade, and turn radii.

In Summary

1. Under actual operating conditions the exhaust system surface temperature of some pickups and sedans reach temperatures in excess of 1,000°F. This temperature is not greatly affected by the installation of an exhaust emission pollution control device.

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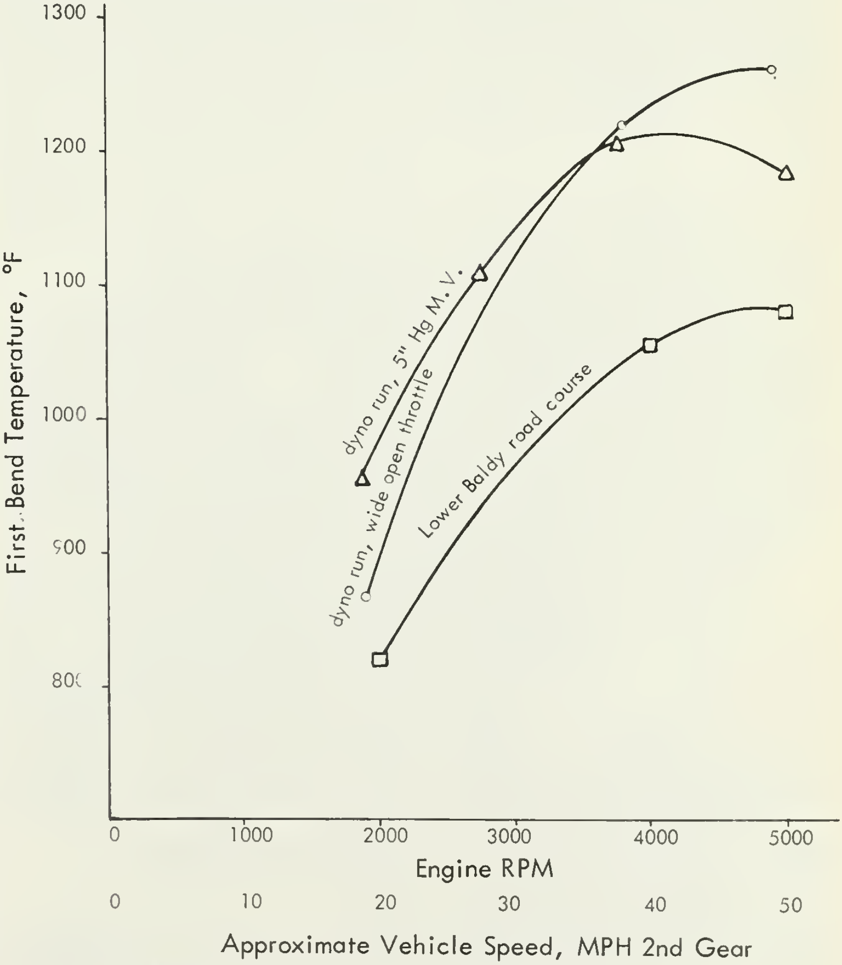

Figure 3—First Bend Temperature as a Function of Engine Speed.

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2. The maximum exhaust surface temperature is reached after sustained operations at high load and engine speed. Such conditions would be encountered climbing a long grade or operating a tanker equipped with a power take-off pump.

3. Exhaust pipe temperature can be significantly raised by maladjusted ignition timing or other engine tuneup setting.

4. Parking a vehicle off-road on a hot day is equivalent to supplying a sustained "heat-sink" or heat source which can provide the time element necessary for a fire start.

Also in the area of the first bend of the exhaust system are the front axle, steering, and other mechanisms, all of which are potential grass snaggers. Since the hazard can still exist after shut-down, drivers should be extremely cautious during fire weather.

For further information see Equipment Development and Test Report 5100–15, available from the Equipment Development Center at San Dimas. △

TABLE 2.—*Effect of road type on maximum first bend temperature*

1961 Sedan Unequipped
Ambient Temperature 75-92°F

Description of Course	Average Grade (%)	Gear Used	Average Speed (mph)	Maximum First Bend Temp. (°F)
Lower Baldy course described in text	+7½	2nd	40	1140
Freeway, straight and constant	+4	3rd	65	970
Around-town driving	0	2nd, 3rd	35	677
Country road, mountainous terrain	+8	2nd, 3rd	30	930
Forest Service L.U. road	+9-11	1st	15	803

Rates, from page 7.

surface presumably remains at or near equilibrium moisture content, regardless of the amount of moisture within. Such a diffusion mechanism would also explain why the curves exhibit no definite break at fiber saturation point (FSP).

TABLE 1.—*Log drying rates K (log M per hours) and time constants t_c (hours) of some dead, fine materials, untreated and xylene-treated*

MATERIAL	COLLECTION DATE	NUMBER OF RUNS	UNTREATED K	UNTREATED t_c	XYLENE-TREATED K	XYLENE-TREATED t_c
Red pine needles	October	4	.041	10.5	.29	1.5
Red pine needles	May	4	.103	4.2	.41	1.1
Jack pine needles	May	1	.137	3.2		
White pine needles	May	1	.158	2.7		
Trembling aspen leaves	October	2	.201	2.2	.60	0.7
Trembling aspen leaves	May	1	.306	1.4	.60	0.7
Grass [1]	May	1	.22	2.0		
Reindeer moss [1]	May	1	.26	1.7		
White pine twigs 1/16 in. D.		1	.338	1.3		
White pine twigs 1/8 in. D.		1	.274	1.6		
Match splints		2	.226	1.9		
White pine slats 10 x 1/4 x 3/32 in.		2	.277	1.6		

[1] Drying curves of these materials deviated considerably from the exponential; their drying data are therefore questionable.

Findings

1. Some fine materials, particularly pine needles, dried slower that wood many times their thickness.
2. Removal of wax and resin with xylene greatly increased the drying rate of pine needles and aspen leaves.
3. Several months of weathering distinctly increased the drying rate of dead leaves.
4. In none of the tests was there any apparent change in drying behavior at the FSP.

Application of Findings

The laboratory test conditions do not exactly fit any specific outdoor situation. They best resemble a fine, calm, summer afternoon in a fully canopied forest. In such a place and in most Canadian weather, the test materials would dry too slowly to reach moisture equilibrium in one day. A satisfactory estimate of afternoon moisture content would therefore require knowledge of the moisture content at some previous time. This principle was followed in the design of the Canadian fire danger rating system, which refers to a forest fairly well sheltered from wind and sun.[2] Specifically, in the analysis of the fuel-moisture data collected in the field, the current moisture content was correlated with the previous afternoon's value as well as the pertinent weather elements. The resulting fine-fuel tracer index[3], used with noon weather readings, provides reasonably good estimates of fine fuel moisture content from day to day. △

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[2] Beall, H. W. Research in the measurement of forest fire danger. Proc. Fifth Brit. Empire Forest. Conf. 1947. Reprinted as Inform. Rep. FF-X-8, Can. Dep. Forest. and Rural Develop., Forest Fire Res. Inst., Ottawa, 1967.

[3] Beall, H. W. Forest fire danger tables, provisional. 2nd edition. Forest Fire Res. Note No. 12, Forest. Br., Can. Dep. Resources and Develop. 1948. (Now Forest Fire Research Institute, Department of Forestry and Rural Development) Ottawa.

Portable Retardant Mixing Unit

L. E. Rossi[1]

A portable retardant mixing unit recently has been evaluated by the SDEDC. The unit can be set up quickly at any suitable airport to mix and load retardant in fixed-wing air tankers, or at any heliport or helispot with road access. It can service helicopters equipped with either a tank or a sling-mounted, dip bucket.

The Set-up

The unit includes a diesel tractor with a 5,000-gallon tank trailer (fig. 1) and a tractor with a 35-foot flatbed service trailer. The service trailer is used to haul up to 25,000 pounds of dry retardant and all hoses and attachments necessary to load the mixed retardant into any aircraft. An Orland mixer and 200-gallon-per-minute loading pump are mounted on the tank trailer (fig. 2). A 1,500-gallon portable open tank is also included. The tank serves as a reservoir for mixed retardant and as a dip tank if helicopters with sling-mounted buckets are used.

Ready Quickly

The unit is set up and operated by a 4-man crew. It can be in operation and the 1,500-gallon tank can be filled with retardant within 20 minutes after the unit's arrival at the mixing site. △

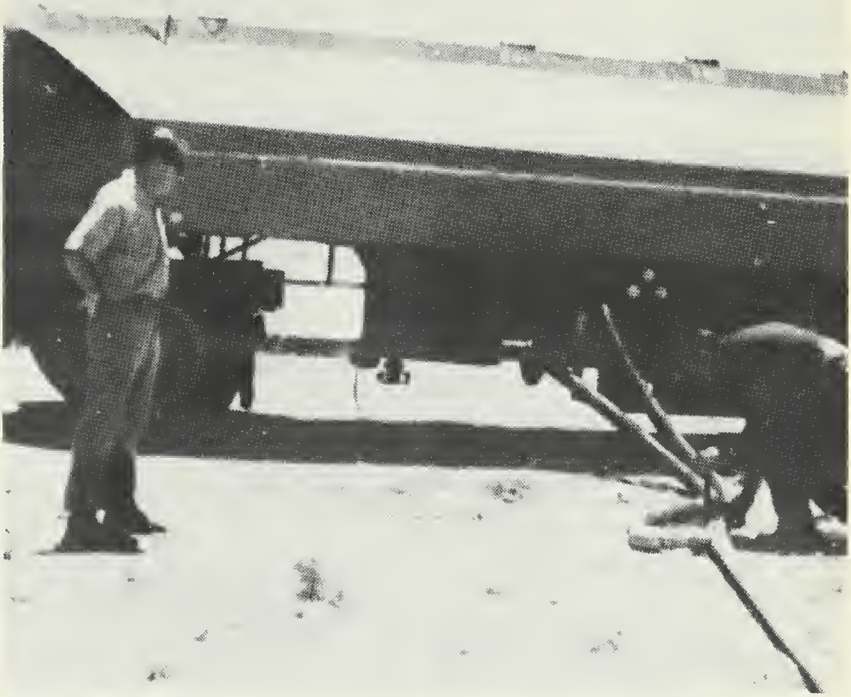
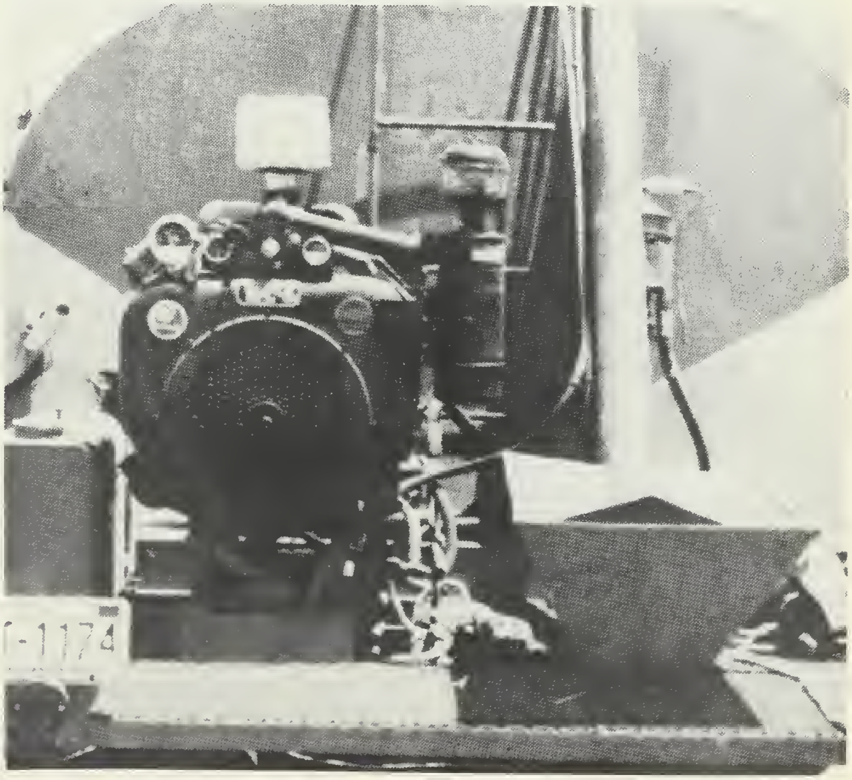


Figure 1—The 5,000-gallon tank trailer is set up to pump mixed retardant.

Figure 2—The retardant is mixed in an Orland mixer mounted on the rear of the tank trailer unit.



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[1] Staff Assistant, Equipment Development Center at San Dimas.

Fire Kill In Young Loblolly Pine

Robert W. Cooper and
Anthony T. Altobellis [1]

Mortality in young loblolly pine, following exposure to free-burning fires, appears to be more closely related to crown damage than to bole damage. Kill of young trees varies considerably with the type of fire applied; trees larger than 4 inches d.b.h. are not easily killed by backfires or small head fires under moderate burning conditions.

If foresters are to make maximum use of fire as a silvicultural tool, they need to know more about mortality of trees exposed to free-burning fires. How does fire kill trees? Is it by means of penetrating heat on the bole that raises the temperature of the cambium above the lethal level? Or, is it the result of crown kill from excessive heat, i.e., bud damage, needle scorch, or consumption? Answers to these questions would enable forest managers to make more precise fire prescriptions and perhaps improve predictions of expected mortality following wildfires.

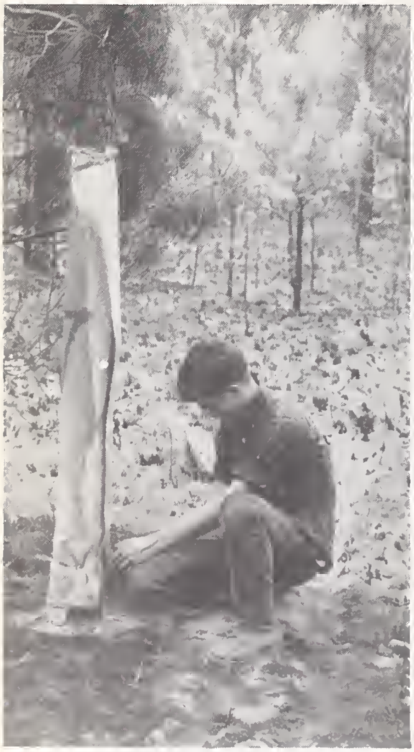

Figure 1—The lower 6 feet of tree boles were protected from heat by asbestos wrappings.

The Search

To find some answers, an exploratory fire study was established in a natural stand of sparsely stocked, young loblolly pine (*Pinus taeda*) in central Georgia. Dominant and codominant trees ranged in height from 8 to 28 feet and in diameter from 1 to 6 inches. Within each of three tracts about 10 acres in size, 36 trees representing three diameter classes (2 inches and less, 2.1 to 4.0 inches, and 4.1 to 6.0 inches) were measured and marked for observation.

Protection

On each tract, bole protection was provided for one-third of the trees, crown protection for one-third, and one-third were left unprotected. One tract was burned with a backfire, one with a head fire, and the last with a perimeter, or ring, fire.

Protection for the boles was provided by asbestos wrapped to a height of 6 feet (fig. 1). Crown protection was provided by sheets of asbestos-covered plywood at the base of the crowns (fig. 2).

Tracts Burned

The tracts were burned in May during a period considered favorable for prescription fires. Air temperature was about 85° F; relative humidity ranged from 40 to 50 percent; fuel moisture estimates were 8 to 10 percent, and 20-foot open windspeeds averaged 5 m.p.h. Surface fuels consisted mostly of pine litter and grass, typical of old fields in the South. Bole char, crown scorch, and crown consumption were estimated soon after burning; a mortality count followed 3 months later.

Results

Crown damage was apparently more responsible for tree kill than bole damage (table 1). Only one tree that was provided with crown protection died; five of the bole-protected trees died. The greatest kill was experienced where no protection was provided; perhaps there is an interacting effect when both bole and crown are injured. Nevertheless, crown consumption proved to be the best of all the fire-damage indicators in predicting subsequent mortality.

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[1] Mr. Cooper is Principal Fire Behavior Scientist, Southern Forest Fire Laboratory, Southeastern Forest Experiment Station, Macon, Georgia.

Mr. Altobellis is Research Forester, Southern Forest Experiment Station, Starkville, Mississippi. Mr. Altobellis was part of the study team at the Southern Forest Fire Laboratory when these investigations were made.

Perimeter burning resulted in the greatest mortality (12 trees); backfiring caused the least (1 tree) (table 2). Only two trees in the largest size class were killed; both of these had unprotected crowns exposed to the perimeter fire. Five trees in the smallest size class and ten trees in the intermediate size class died. The best explanation for the greater kill in the intermediate class is that six of the ten dead trees were located in the center of a developing convection column in the perimeter-burn tract.

Conclusions

This evidence indicates: (1) kill of young loblolly pine varies considerably with the type of fire to which trees are exposed; (2) mortality is more closely related to crown damage than to bole damage; (3) loblolly pine trees larger than 4 inches d.b.h. are not easily killed by the heat from backfires or small head fires under moderate burning conditions; (4) when convection activity develops, perimeter, or ring, burning is capable of killing more and larger trees than it otherwise would.

Although additional research and operational trials are necessary before this evidence finds practical application, some interesting possibilities come to mind. For example, hazard reduction burns in young loblolly pine stands appear feasible where backfires and strip head fires can be applied under moderate weather conditions. Prescription fires may also deserve consideration as precommercial thinning tools (thinning from below) in dense stands of young loblolly pine where diameters range from 1 to 6 inches.

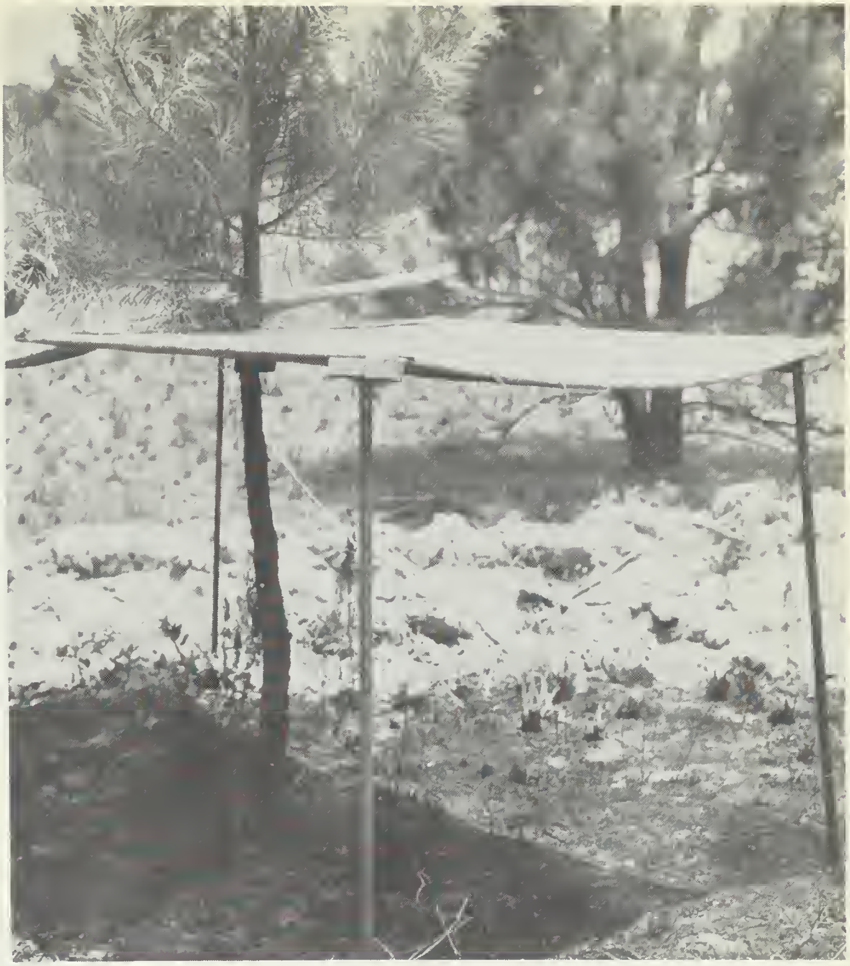

Figure 2—Crowns were protected from direct heat by asbestos-covered sheets of plywood.

In this study, no consideration was given to the indirect effects of fire in attracting insects or enabling disease organisms to become established. These factors certainly warrant study in future work. △

TABLE 1.—*Effects of free-burning fires on young loblolly pines*

Protection provided	Bole bark char	Crown scorch	Crown consumption	Dead
		Number of trees [1]		
Crown	29	22	0	1
Bole	4	31	11	5
None	33	36	19	11

[1] Because some trees exhibited varying degrees of damage in both the crown and bole, number of trees in each protection class will not total 36.

TABLE 2.—*Mortality of young loblolly pine in relation to type of fire, protection provided, and size (d.b.h.) class*

Type of Fire	*Number of trees killed*								
	Crown protection			Bole protection			No protection		
	< 2″	2.1″-4.0″	4.1″-6.0″	< 2″	2.1″-4.0″	4.1″-6.0″	< 2″	2.1″-4.0″	4.1″-6.0″
Back	0	1	0	0	0	0	0	0	0
Head	0	0	0	1	0	0	0	3	0
Perimeter	0	0	0	0	3	1	4	3	1

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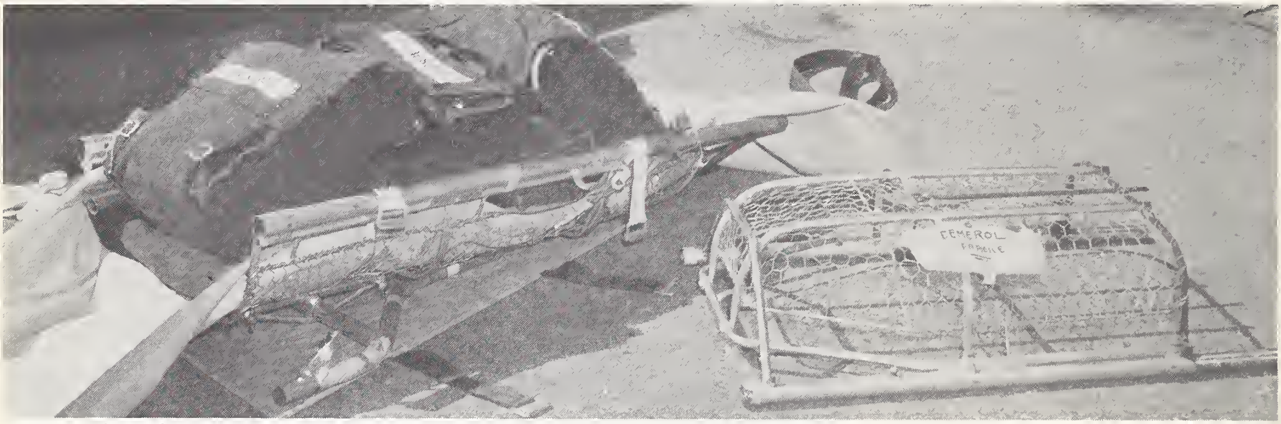

Figure 1—The Stokes litter disassembled, with cargo rigging removed, showing contents stowed in the two parts.

Stokes Litter Modified

Ken Smith [1]

In order to eliminate hazards in para-dropping the Stokes Rescue Litter, aircraft technicians on the Boise National Forest redesigned the litter by dividing it into two sections for packaging and paradropping.

The Stokes litter was cut into two sections, one 31 inches long and the other 50 inches long, the latter section long enough to mount the wheel yoke assembly (fig. 1). A length of strap metal was formed and welded into place on each section where the cut had been made; wire mesh was spot-welded to these straps. On the shorter end of the litter, a piece of strap was used for added reinforcement, and a bolt plate was attached for mating to the long section. Two sleeves were machined to size and slid into the top rail. These sleeves were 16 inches long, of which 8 inches were inserted and bolted into place in the short length of the litter. After the sleeves were secured, both ends were placed back together and two 1/4-inch bolt holes drilled on each side (fig. 2). Stove bolts with ring nuts were used to speed the assembly.

Color-Coded

All carrying handle extensions were color-coded to speed assembly, and all crew evacuation harnesses were labeled properly so even an untrained crew would have few problems. A quickly attachable package for Demerol, etc., was located on exterior of the bundle where landing impact would not damage the contents. This first aid package also included instructions for assembling the unit.

During training sessions on the Boise, this modified litter has been put together in 5 to 8 minutes by men with no previous experience in assembling it.

Plans for modifying the Stokes litter are available from the Forest Supervisor, Boise National Forest, 413 Idaho Street, Boise, Idaho 83702. △

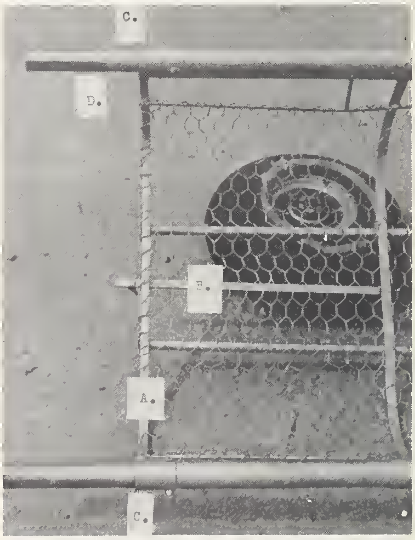

Figure 2—Shorter section of Stokes Litter showing modifications:

A. Metal strap
B. Reinforcement & bolt-plate assembly.
C. Sleeves
D. Sleeve boles.

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[1] Smokejumper foreman, Boise National Forest.

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